The Dock & Harbour Authority

No. 492 Vol. XLII OCTOBER, 1961 Monthly 2s. 6d.

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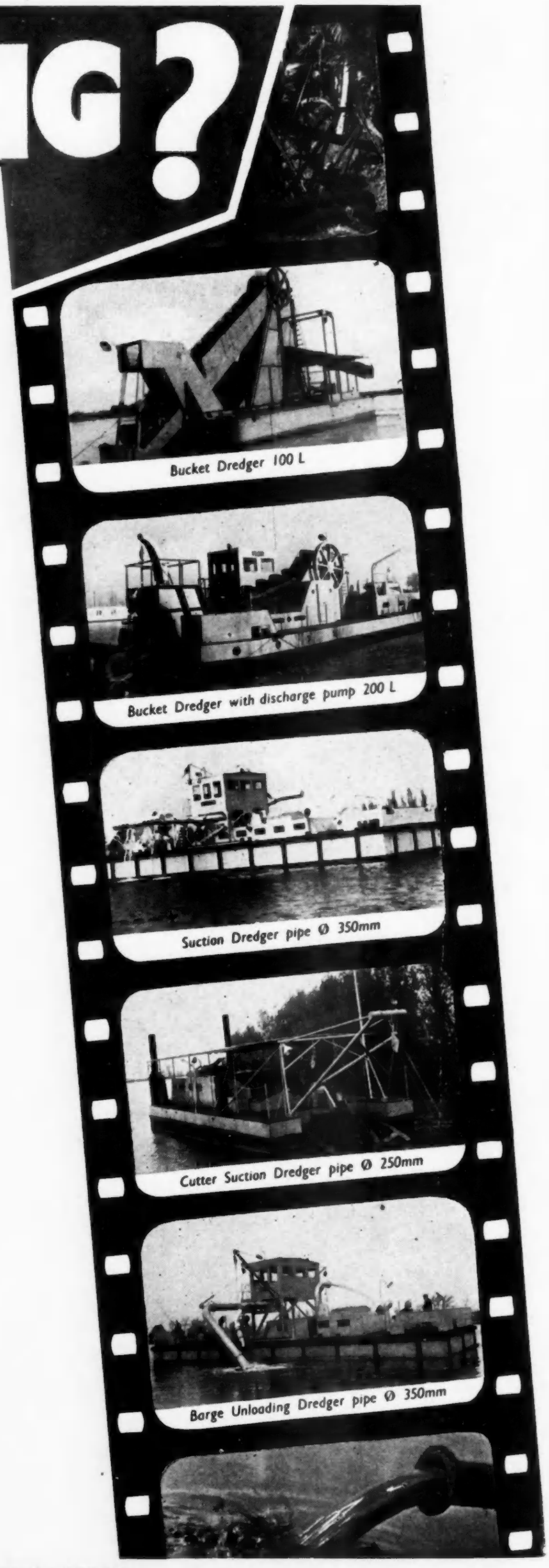

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Editorial Notes

Mourilyan Harbour, Northern Queensland

We believe that the series of three papers describing the development of Mourilyan Harbour, which recently appeared in the Proceedings of the Institute of Engineers, Australia, will prove to be of exceptional interest to our readers. Accordingly, by kind permission of the Institute, we are printing in this issue the first two papers which deal respectively with the harbour development works and the harbour model constructed by the Department of Civil Engineering, University of Queensland. The third paper, describing the new Bulk Sugar Terminal, and the discussion on all three papers will appear next month.

The development of a single terminal for the bulk loading of semi-refined sugar in ocean vessels in a little known part of Northern Queensland is not, of course, in itself, a matter of world-shaking importance. Neither are the peculiar topographical features at Mourilyan likely to be encountered in many other situations. The merit of the work lies rather in the manner in which an unusual problem has been examined by a highly competent team of investigators, who have set out their observations and conclusions in a form which is consistently interesting, and by laying a ground work of sound academic study related all the time to the practical problems of utilitarian needs, the subject has been presented in a way which can scarcely ever have been bettered.

In undertaking the basic model investigations the Engineering Faculty of the University of Queensland in Brisbane has shown a remarkable flair for technological work in this field. It might be thought that the tidal mechanism employed was over-elaborate for the particular work on hand but it should be remembered that the system was originally devised for a major investigation of tidal conditions on the Fitzroy River, near Derby, in the Kimberley region of Western Australia, and itself formed part of a larger inquiry into the stability of channels formed in alluvium. It can, and doubtless will, be used again in a variety of other assignments. As described in this paper it provides a particularly clear analysis of tidal phenomena which are often difficult to comprehend.

The situation at Mourilyan must be almost unique. The harbour area, about a square mile in extent, is in fact a submerged valley containing a great depth of alluvial silt. Entry from the sea is by a ridge of rock with a limiting depth of 18-ft. of water over it. Deep water exists on the seaward side and on the landward side the alluvium has been scoured out as deep as 70-ft. in places over an area sufficient to allow turning space and berthing accommodation for large ocean going vessels. Under the influence of the tides the rock bar appears to function as a drowned weir setting up vertical currents which, however, seem on balance to have established a stable regimen in the alluvial bottom, with no sensible accretion or removal of this easily eroded bed material. For some time the enclosed water area has been used by coastal vessels and by lighters transporting sugar from three mills in the vicinity to Cairns, some 70 miles to the north, but the growing cost of these long range lightering operations has understandably focussed attention on the possibility of opening the harbour entrance to deep draught ocean vessels able to load sugar in bulk.

It will be remarked that between 1884 and 1912 the rock bar has progressively been deepened first from 4-ft. 3-in. to 12-ft. and later to 18-ft. over a width of 180-ft., with some consequential, but not on the whole significant, shoaling around the fringes of the basin. Obviously, therefore, a proposal to deepen the bar to 28-ft. or more, and to provide an access channel 220-ft. wide was viewed with some hesitancy, not so much on account of the cost of underwater drilling and blasting of the rock obstruction as on the possible adverse effect of changing the entrance conditions which alone might be responsible for maintaining an extent of trouble-free water inside.

The account of the investigations undertaken to forecast the likely consequences of deepening the entrance makes fascinating reading. Although it was possible to reproduce in model form the observed tidal characteristics in nature and to develop a plausible theory to account for the configuration of the bottom, the model tests were in fact somewhat inconclusive as to the consequences of enlarging the harbour entrance. It now seems to be well established that little or no fresh material is entering the basin and that which exists already is being recirculated and deposited according to the pattern of energy dissipation of the underwater currents generated, but the critical velocity necessary to pick up and transport very fine bed material cannot be simulated in model tests where the actual velocity of flow is of a lower order. A closer approximation to dynamic similarity was achieved in the later floc tests which, on the whole, gave a better indication of the probable outcome.

The course of the experiments shows very clearly how much or how little reliance can be placed on the predictions of model tests however ingeniously contrived, in forecasting the movement of finely divided, easily eroded bed material under actual tidal influences. It seems inevitable that some redistribution of the bottom material will occur now that the work of removing the bar obstruction has been completed (and engine movements will contribute to the process) but whether or not any considerable dredging maintenance will be called for is something which time alone can decide. Certainly the advantages already secured are such that a reasonable expenditure on that account might be faced with equanimity.

I.C.H.C.A. New York Conference.

Methods of packing and transporting goods and materials have probably never changed so quickly as in the last decade. During that period, general cargo vessels, traditional carriers of piece goods, have been transporting increasing quantities of strapped unit loads, cargo on pallets, materials in bulk, containers and other heavy packages. Ships' handling equipment, too, has been evolving. During recent years there has been a considerable increase in the lifting capacities of derricks and in

the speed of ship's winches; deck cranes have been installed on or above hatch coamings, hold space has been made more accessible and much more suitable for the operation of handling machines and many new vessels have been constructed with mechanically-operated hatch covers. Each of these developments has had an effect upon mechanical handling methods; together they have certainly posed many handling problems.

The stated object of I.C.H.C.A. is "to serve its members who are interested in improving cargo handling, by promoting contacts between them with a view to increasing the efficiency and economy of sea-borne trade and all forms of transport connected with it". That I.C.H.C.A. is succeeding in its purpose will be clear when it is stated that its fifth biennial conference, held in New York in September, 1961, was attended by representatives from at least 23 nations.

Of the nine papers presented, two dealt with the much-discussed "Collective bargain" made between Employers and Union on the Pacific coast waterfront of the United States. This bargain is the first if its kind in the port industry and there will be much controversy about its present and future implications. In a third paper, an imaginative attempt was made to predict the pattern of the port of the future and, since the authors based their layout on the belief that a high degree of containerization of general cargo is an inevitable development, this subject, too, was extremely controversial.

Extracts of the three papers mentioned are printed on following pages of this issue. The next General Assembly and Technical Conference of I.C.H.C.A. will be held in London in 1964.

Future of U.K. Inland Waterways

In view of the pending re-organisation of the British Transport Commission, the National Association of Inland Waterway Carriers has published its views on what should be the future administration of the inland waterways of the United Kingdom.

The Association is of the opinion that the losses incurred by British Waterways mainly arise from the maintenance of hundreds of miles of canals for little or no commercial traffic and uneconomic carrying services, e.g. narrow boat traffic which independent operators with their wide experience had already found non-paying. The Bowes Committee Report of 1958 brings out these facts, say the Association, and the form of administration revolves round the following main issues: (1) Upkeep and development of the waterways (class A) which are of prime commercial use; (2) Maintenance and to some extent development for commercial traffic and other purposes of waterways (class B) lightly used for traffic; and (3) The future of other waterways (class C) which, while they may be a heavy charge on a Waterway Authority, have little value except for water supplies, drainage and amenity purposes.

It is the strong opinion of the Association that the problems attendant on these aspects of the waterway system cannot be efficiently dealt with by a central authority in London but only by reverting to the policy of on-the-spot administration as was the case prior to nationalisation. Each division of British Waterways with its commercial, estate, water and other functions is, in comparison with any organisation, a sufficiently large unit for effective administration and there is little in common between present divisions of British Waterways to justify a large central organisation.

In the light of their experiences under conditions of free enterprise, Ministry control and nationalisation, the Association recommends that there should be appointed, under the Minister of Transport, a Director of Canals. Under the Director there would be four regional boards: for the South East, South West, North East and North West regions. Each board would have its general manager and under him the chief engineer, traffic officer, estate officer, accountant and personnel officer. The Director, as co-ordinator of policy would be chairman of each regional board. He would also be the link between the regions and the Ministry on matters of overriding policy, finance and development.

The regional boards would need to vary in constitution because in some regions commercial interests predominate, whereas in others the other "uses" of waterways may claim importance. It is suggested that on each board there should be part-time representatives of industry and commerce, carriers and, where appropriate, amenity and other users. In certain respects it would be useful to have a River Board representative as there is an affinity of interests in some ways, e.g. River Trent and Weaver Navigation.

The Association's recommendations say that where a dock forms part of an inland waterways system (e.g. Goole, Regents Canal Dock, Gloucester) the special position of the waterways interests must be safeguarded and these docks should remain attached to the waterway. The position of Goole, which has been transferred to the present Dock's administration of the British Transport Commission, would have to be reviewed.

In making their recommendations, the Association points out that independent carriers still handle up to 90% of the tonnage passing over the inland waterways system and in tolls they contribute between 25% and 30% of the gross revenue.

Proposed Link with the Continent

At a press conference of the Channel Tunnel Company held at the British Transport Commission headquarters in London on 16th October last, it was stated by M. René Massigli—a former French Ambassador in London and now Chairman of the French section of the Channel Tunnel Study Group—that the French and British Governments are to discuss next month whether or not to proceed with the 80-year-old proposal to construct a link (either a tunnel or a bridge) between the two countries.

Explaining the purpose of the meeting and reporting on recent developments, Mr. Leo d'Erlanger, Chairman of the Company, said that he thought there was no longer any question of the British Government being worried on grounds of defence and that a tunnel would cost half as much as a bridge—£105 million against £210 million. The capital would be raised in Britain, France and the United States, and the construction works could be completed in five years by a labour force of only 3,000 men.

Giving the reasons for his preference for the tunnel, Mr. d'Erlanger said the tunnel terminals would be so sited and conceived as to drain off traffic well short of the congested coastal areas, whereas the siting of the bridge would only intensify this frustrating inconvenience. He also stressed the navigational hazards which would be presented by a bridge and referred to the article on this subject which appeared in the May 1961 issue of this Journal.

Mr. A. B. Valentine, a member of the Study Group and of the British Transport Commission said the tunnel project had the support of the Commission, as was stated in their Annual Report for last year. A working model of the proposed terminal on the English side of the channel, made by the B.T.C., was on display. The site of the terminal would be about six miles from Folkestone and would be linked with the new motorway from London to the Thanet coast; it would have a traffic capacity far in excess of any likely demand in this century.

There is no doubt that, if and when agreement is reached concerning the question of Britain joining the Common Market, a direct link with the Continent, be it either a tunnel or a bridge, would have an appreciable economic influence on European trade. In view of the considerable correspondence on the subject which has been ventilated in the daily press during recent weeks, we are publishing next month an article by Mr. H. J. B. Harding, B.Sc., M.I.C.E., which gives a balanced assessment of the arguments which have been propounded by advocates of both schemes.

Mourilyan Harbour, Australia

Description of Recent Improvements Effected

Three papers describing the development of Mourilyan Harbour were presented before the Engineering Conference at Cairns, Australia, in May 1960 and are being reproduced in this Journal by kind permission of the Institute of Engineers, Australia. Parts 1 and 2, which deal respectively with the Harbour Development Works and the Mourilyan Harbour Model are printed in this issue. Part 3, which describes the Bulk Sugar Terminal will be printed in our November issue together with abstracts from the Discussion on all three Papers.

Part I gives a short account of the history of Mourilyan Harbour, the deepening of the entrance in the year 1884 from 4-ft. 3-in. at Low Water to 12-ft., and in 1912 from 12-ft. to 18-ft., and finally the present day work involving drilling and blasting of the rock entrance to provide a depth of 28-ft. Low Water.

The design and construction of a reinforced concrete wharf, 633-ft. x 45-ft., capable of accommodating overseas vessels up to 460-ft. in length, is described with some detail.

Part II sets out that there was a considerable body of opinion that the existing form of the Harbour was due in some way to entrance conditions and that any change would destroy the present limited facilities. It describes the construction of the model and the basis of the scale adopted, and concludes that the model showed the true causes of the present conditions and allowed a real estimate to be made of the risk of adverse change resulting from opening the entrance.

Part III briefly refers to the adoption of bulk sugar handling in Queensland and describes the installation at Mourilyan Harbour. Reference is made to the factors leading to the adoption of the particular type and size of storage and features of the structural design; in particular the steel frame and the reinforced concrete retaining walls are discussed. The results of a series of tests to determine the properties of raw sugar and an analysis of these results are tabled. A precis of retaining wall design considerations, particularly under conditions of maximum positive surcharge, is included together with a short statement regarding construction work to October, 1959.

Part I.

Mourilyan Harbour Development Works

By E. C. FISON, B.E., M.I.E.Aust.
(Chief Engineer, Department of Harbours and Marine, Queensland)

Mourilyan Harbour is very difficult to discern from the sea. The opening in the coastline is but 500-ft. wide and the background, some 6,000-ft. from the heads, is fringed with mangroves surmounted by typical Australian trees on the high ground.

The first Admiralty chart of Mourilyan Harbour bears the date of 1882 with the noting that it has been prepared from a chart by the Queensland Government. The survey was made by Mr. G. F. Eliott, afterwards Deputy Engineer, Department of Harbours and Rivers, Queensland. This chart shows that Channel Rock in the middle of the entrance had a depth of 4-ft. 3-in. over it at Low Water Spring Tides. The limiting depth was therefore 4-ft. 3-in.

In 1884, the Queensland Government decided to improve the entrance, and with this in view engaged Captain William Collin to deepen the entrance from 4-ft. 3-in. to 12-ft. Low Water. The adventurous pioneering spirit was well to the fore when Captain Collin took the ketch "Enterprise" (replica of a Thames sailing barge) from Brisbane to Mourilyan Harbour. The work was performed by drilling and blasting, together with a good deal of plaster blasting. Charges were placed in rock crevices. The work took approximately 5 months.

By 1910 it was found that vessels using the harbour required a greater depth than 12-ft. Low Water. The moderate sized coastal vessel used the port to carry sugar to Victoria and New South Wales.

The small grab dredge "Mourilyan," 103-ft. x 23-ft., was built with its bottom shaped rather like the longitudinal half of an egg. This shape was adopted to reduce the vessel's resistance to the strong tides in the entrance. The method of working was very simple. A steam piston drill of the Ingersoll-Sargeant type was adopted. The stroke of the drill was 8-in., the bore of the cylinder 4½-in., the drill steel 1½-in. octagon 40-ft. long. The long drill steels had no guides, but the drill was permitted to chatter away until a crater was formed into which the drill finally centred itself. The cutting bit was cruciform and 2½-in. across the points. A diver was employed to load the hole with 3 lb. of blasting gelatine and the charge was detonated by means of an electric detonator and a rack bar exploder.

A channel 18-ft. deep and 180-ft. wide was therefore provided by 1912, and the Engineer for Harbours and Rivers of that time, Mr. E. A. Cullen, I.S.O., M.I.C.E., expressed the opinion in a very definite and forthright manner, that any further increase in depth would change the harbour from a dredging free port to one with a considerable maintenance problem. The existence of the deep hole some 1,000-ft. wide and 70-ft. deep, the presence of swirling currents and the proximity of the Moresby River, which was practically dry at low water, gave strength to this view.

Before the advent of the bulk handling of sugar, it was in the interests of Mourilyan Harbour and in the very economy of the port that its annual maintenance should be low, but with the coming of bulk handling of sugar it became clear that sugar from South Johnstone, Goondi and Mourilyan Mills, with perhaps Tully and Babinda, could be more cheaply exported from Mourilyan Harbour by coastal vessels of the "B" class (405-ft. x 53-ft.). These vessels would carry the sugar to Pyrmont in Sydney and Yarraville in Melbourne. The sugar was entirely for home consumption. It was necessary to widen and deepen the entrance for these ships. The Queensland Sugar Board, with an eye to the economical export of sugar, now began to consider Mourilyan Harbour as an overseas port. The harbour will eventually be deepened to 28-ft. L.W.S.T., and will accommodate vessels 460-ft. long. For the time being vessels will be limited to 460-ft. O.A. length. Turbine-propelled vessels, due to their poor sternway power, will not be permitted to use the port. This restriction will, it is felt, be short-lived and ere long larger vessels including tankers, will frequent the port.

Mourilyan Harbour is only 70 miles south of Cairns, yet it was economically sound to develop it as a deepwater port. The saving to the Sugar Industry in freight will vary between half a million and three-quarters of a million pounds per year. This saving is made mainly on account of the elimination of the sugar lighters. Freight on sugar, Mourilyan to Cairns, is £4 per ton. The port could operate with a large dredging account and still remain financial.

It is interesting to note that silt examination of the harbour waters during 12 months in 1956 revealed practically no silt in the water. The Moresby River, like Trinity Inlet, is a drowned valley and in both cases silting is small. Cairns has a very low annual dredging cost for its wharf berths. Some silting has, nevertheless, occurred at Mourilyan Harbour during a period of 35 years. The wharf was extended in 1923 and in the shingle bottom that existed then, there is now at least 5-ft. of silt.

The development of Mourilyan Harbour as a deepwater port in the light of sugar export was a foregone conclusion long before results of the model experiments were made known. The problem was to determine the work necessary to make the port suitable for large coastal ships and the medium type of tramp vessel.

A study of Fig. 1 will indicate the problem. In Queensland ports entrance channels vary in width, e.g., in Brisbane the width

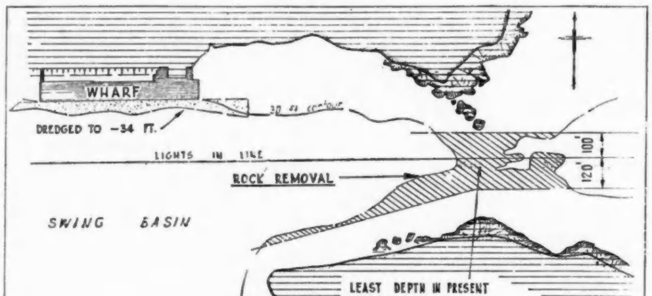


Fig. 1.

for two-way traffic is 400-ft., Townsville for one-way traffic 250-ft., Bowen 200-ft. wide, while in Cairns the bar cutting some 4 miles long is 150-ft. wide. In all four ports movement of shipping has taken place with, one can say, no difficulties due to the width of the cutting. After consultation with Marine Superintendents, Harbour Masters and Pilots, it was decided that a width of 220-ft. would be ample for vessels of 70-ft. beam using Mourilyan Harbour, that is to say, a vessel entering the port, if it adhered to the centre of the channel, would have a clearance from the rocks on each side of 75-ft. A ship entering the port will, however, require a certain speed to maintain steerage way. The current, if any, will be true to the line of leading beacons, but the wind will frequently be either on the quarter or on the bow, and consequently a certain amount of speed will be necessary. What "way" the ship will carry will depend on the whim of the pilot, but whether it be great or small it must be reduced to zero before the ship reaches the Western end of the harbour.

Fig. 2 shows the method of ship handling. The pilot will by shore marks know where to let go the vessel's anchor and, if necessary, a tug will be provided to pluck the vessel's bow round. The type of tug required will be a vessel 65-ft. long and powered with a 240-ft. h.p. diesel engine.

In short, model experiments were made to determine the effects that would result should the entrance be widened, Harbour Masters and Pilots were catechised as to the method of handling the ships, and finally a recommendation was made to the Treasurer of Queensland stating that the deepening of Mourilyan Harbour was economically sound, that it would be a port that could be operated by seafaring men and finally that it could be widened and deepened.

The engineering work from the harbour engineering point of view then resolved itself into the widening and deepening of the entrance and the construction of a reinforced concrete wharf at which medium size overseas ships could load sugar in bulk.

Widening and Deepening of Channel Entrance

The removal of submarine rock may be performed in several ways, and in Queensland ports this has been done in two ways:

(a) Bucket dredge without the assistance of explosives.

(b) Drilling, blasting and dredging.

The rock that forms the barrier at the entrance to the port has been described by the Queensland Government Geologist as a metamorphosed chlorite schist which is not exceptionally hard. The rock, however, is fissured with quartz veins varying from 1-in. to 2-in. thick.

Various plans are available which show Mourilyan Harbour in 1882, 1912, and finally in 1954. Before any work was contemplated and in order to provide the University of Queensland with information upon which to build the model, a survey party in the survey launch "Ferret" visited the port and made a detailed survey of the harbour.

The survey launch "Ferret" is 45-ft. long, 11-ft. 6-in. beam, and at the time had the latest Mark 21A wet paper echo-sounding machine. This machine has a scale of approximately one-ninth inch on the paper to one foot of actual depth. The dry paper is a later improvement and is used in other echo-sounding machines operated by the Department.

Tidal currents were observed during flood and ebb tide using a pole 14-ft. long, as shown in the diagram (Fig. 3). A float such as this will give the mean current for a depth of 14-ft. Fig. 4 shows the current observations, the track taken by the float and the strength of the tidal current at various states of the tide.

Velocities at spring tides reached five knots and a neap tides 3 knots. It is worthy of note that every three or four weeks the semi-diurnal tide almost disappears and the diurnal tide predominates. During this period, lasting for two or three days, there is a tidal range of approximately 3-ft. and very little current velocity.

An attempt was made to reproduce the actual currents in the model. The model did so, although the currents do not follow any well defined plan and it became clear that the swirling current which was supposed to keep the port clear of silt did not exist.

The horizontal circular current was not to be found, but the rocky bar at the entrance made manifest an inclined current. This current is violent and no doubt has produced the deep water to seaward of the entrance and in the harbour itself. So strong is this current that during current measurements the float was taken down and the end jammed in the rock crevices.

During the progress of the survey an automatic tide gauge, "Esdaile" type, recorded the time and height of the tide. From these tidal records and with the assistance of Admiralty Tide Tables, Part III, four harmonic constants were computed, viz:

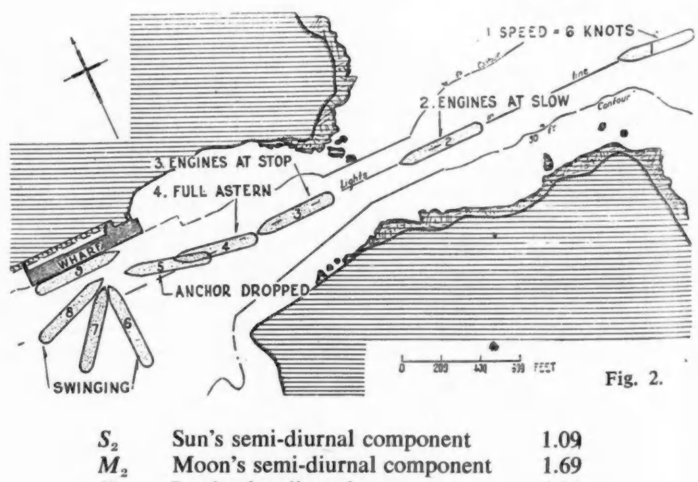


Fig. 2.

S_2	Sun's semi-diurnal component	1.09
M_2	Moon's semi-diurnal component	1.69
K_1	Luni-solar diurnal component	1.02
O_1	Lunar diurnal component	0.44
A_0	Mean sea level	4.24

The datum for all soundings is Indian Spring Low Water which in terms of the harmonic constants is:

$$A_0-(H \text{ of } S_2+H \text{ of } M_2+H \text{ of } K_1+H \text{ of } O_1).$$

This datum falls well within the definition of a datum at one time used by the Hydrographic Branch of the Royal Navy, viz.—A plane so low that the tide seldom falls below it.

In November, 1958, the rock drilling barge owned by the Department was made ready for sea. Fig. 5 gives some indication of the type of plant. The barge is 103-ft. long by 30-ft. beam and was built in 1935 for use in the Brisbane River, with even in those days the possibility of work at Mourilyan Harbour or for that matter anywhere else on the Queensland coast. It will be seen that the principle of the barge involves the drilling of a hole in the submarine rock, the loading of the hole with explosive and the eventual firing of the charge.

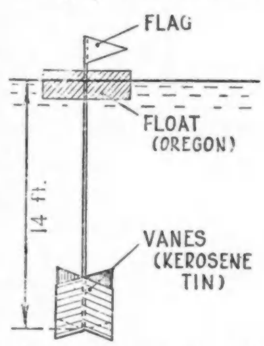


Fig. 3. Diagram of Float.

To drill the hole it is desirable that the drilling barge should remain fixed in position. This has been achieved by the use of four hardwood spuds 16-in. x 16-in. The four spuds when dropped on the rocky bed prevent the barge from altering its position. Holding the barge in one position is not enough—it is necessary to haul the vessel clear of the drilled hole while the charge is being exploded. At each end is a three-drum winch. The barge is moored on six anchors. Each anchor wire consists of a 2½-in. wire rope. With six anchors and four spuds the barge can hold its position and be manœuvred in the strong tide rip of the harbour entrance.

The method of drilling and loading from the surface is essentially an adaptation from the United States of America. Fig. 6 shows the sand box which acts as a guide for the drill. The drilling tower can traverse the length of the barge. Once the barge is moored in position with four spuds down it is possible to traverse the two towers and thereby drill a row of holes—in this case twelve holes—at five-feet spacing.

The hole is drilled by an Ingersoll-Rand W.D.X.71 pneumatic drifter with air supplier to it at a pressure of 100 lb./sq.in. from a steam-driven two-stage air compressor with a capacity of 800 cu. ft. of free air per minute.

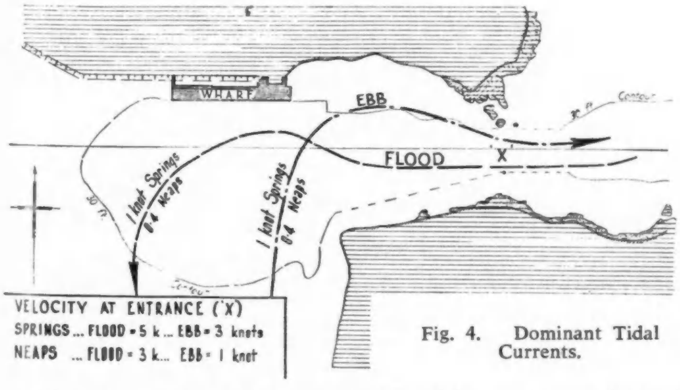


Fig. 4. Dominant Tidal Currents.

This plant was originally supplied with two Ingersoll-Rand H.64 submarine piston-type drills having a stroke of 8-in., but the difficulty of providing spare parts, the frequent necessity for spare parts, and the fact that the machines were many years out of date, made their replacement necessary.

Two Ingersoll-Rand W.D.X.71 pneumatic drifters having a stroke of 3⅜-in. and bore of 4-in. dia., were purchased with 1¼-in. round hollow steel and tungsten carbide bits. In all previous drilling it had been the practice to remove the drillings from the bore hole by means of a water jet. This was satisfactory, but the use of hollow steel and air instead of water would remove the necessity for a ½-in. pipe in the hole along with the drill. Elimination of the jet made it possible to use a smaller hole diameter with consequent more rapid drilling.

Drilling in the rock in calm water in the Brisbane River presented little difficulty. The river reaches are subjected to wind waves of up to two feet in height. The barge was very steady and no trouble resulted. The machines were well tried out in Brisbane before the barge departed for Mourilyan Harbour.

In Mourilyan Harbour it became clear that the strong current was not going to prevent the drills from operating, but the existence of swell had a very undesirable effect. The barge would pitch lazily in the swell and the downward movement of the vessel would jam the drill. The effect of the hammer action or percussion drill was that at one stage of the motion the drill was jammed and at another the drill point was lifted from the rock face.

It became clear later that the swell was not ocean movement, but was due to the outgoing vertical current. Fig. 7 indicates the method of overcoming this. By this device the weight of the drill was always on the point of the drill steel and the drilling bit never left the bottom of the hole.

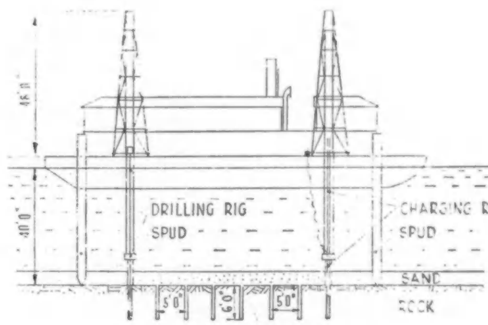


Fig. 5. Rock Drilling Barge.

The method of charging the hole from the surface, that is, without the use of a diver, was achieved in the manner indicated in Fig. 8. This figure shows the charge of gelatine dynamite placed in a cardboard container with No. 8 submarine detonator in one end of the charge and a piece of cordtex along the side of the charge. The charge is exploded with a magneto type of rack bar exploder. Twin wires in plastic were used to reduce the resistance of the strong tides on the wire. During spring tides it was found impossible to load the holes either by diver or from the surface except during a short period of low water and high water.

Spacing of Holes

Drill holes were initially spaced 5-ft. apart in the direction of the line of leads and 5-ft. apart at right angles to the leading beacons. The depth of hole was 6-ft. and the amount of gelatine dynamite used in each hole was 6 lb. However, dredging of the broken rock indicated that the hole spacing was too great. The best results were obtained when the spacing was reduced to 4-ft. using 10 lb. of medium nitro glycerine explosive per hole instead of gelatine dynamite.

The position of the holes in the harbour was determined by transit marks in both directions. No difficulty was experienced in placing the vessel accurately in position.

The barge was hauled clear and the charges, 12 in number were exploded together. A distance of 75-ft. was considered ample.

Plaster Blasting

It was soon found that the rock bottom was a system of rock

pinnacles and, as a preliminary to drilling, two divers were employed in placing the charges in rock crevices. Almost the whole area from 18-ft. L.W.S.T. to 24-ft. L.W.S.T. was treated in this manner, and at this stage the bucket dredge "Platypus II", having completed the dredging of the wharf berth to 34-ft. L.W.S.T., was transferred to the entrance to attempt the dredging of the broken rock.

The "Platypus II" met with rather indifferent success. Some rock was dredged but examination by diver revealed that the dredge buckets were pushing the rock forward and that there were many ridges of rock interspersed with quartz veins which made bucket dredge work well nigh impossible.

The grab dredge "Mourilyan," fitted with a two-cubic-yard Priestman crane, was brought from Brisbane and prepared for work in the entrance, but unfortunately she took in water and capsized and sank in the entrance with the loss of three lives. At date, "Mourilyan" has been raised and has been reconditioned.

Removal of the rock by grab was the method used in the two earlier deepening operations and this would seem to be the better method.

The total amount of rock to be removed from the harbour entrance is 50,000 tons. Some has been dumped at sea (outside the 7-fathom contour) and some in the shallow waters of the Moresby River.

Wharf

The original intention was to widen the timber wharf by 20-ft. and use a fixed sugar loading point. By this means the existing wharf, which still had many years of life, would have been used and the only construction would have been a strip 20-ft. wide, plus foundation piles for the fixed gantry. The strip 20-ft. wide became necessary on account of the greater depth required in the berth. Deepening by bucket dredge "Platypus II" was carried out. "Platypus II" cannot dredge closer to the fender piles than 18-ft.

The objection to a fixed loading point is that the ship must be warped along the wharf on each occasion that it is required to load into another hold. A portion of the crew must remain on board to tend the mooring lines. The ship is loaded in 24 to 36 hours, so that little shore leave is enjoyed by officers and men. The time lost in moving ship is small, but it is an argument in favour of the traversing head when it is remembered that the ship is a girder, and the stresses on the girder are minimised if it is loaded uniformly. The traversing head by its easy movement up and down the wharf permits this uniform loading. It is, of course, pertinent to point out that a ship at sea is continually experiencing stresses due to the unequal loading.

The design of reinforced concrete wharves in Queensland ports has passed through many phases. Wharves were built at Townsville, Gladstone, Bowen, Cairns and Brisbane during the second decade of this century and in every case they followed the same outline. Piles, headstocks, girders, secondary beams and deck slab were used, and to stiffen the structure a system of reinforced concrete walings and diagonal bracing was used.

The Bowen Coal Wharf built in 1925 omitted secondary beams included some raker piles and in the main relied upon reinforced concrete waling and braces to stiffen the wharf.

The main pier at Mackay Outer Harbour was built with reinforced concrete piles and stiffened with steel wales and braces in an endeavour to eliminate the deterioration that invariably occurs with cast-in-situ braces and wales.

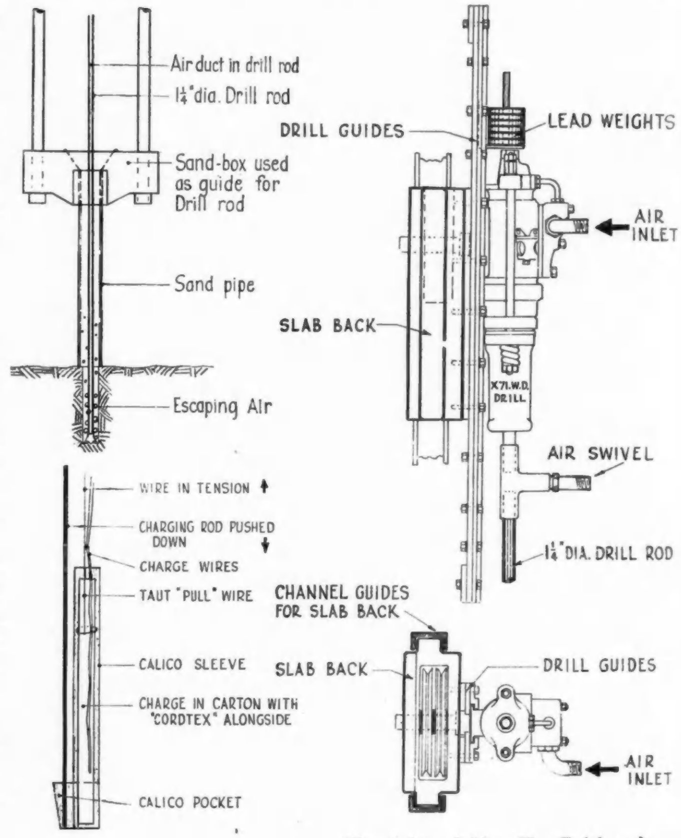
The extension to Auckland Point Jetty at Gladstone was completed in 1956. It consists of headstocks, main piles, raker piles and a flat slab.

The present jetty extension now under construction has main piles, raker piles and a flat slab. Concrete formwork is consequently very simple.

Mourilyan Harbour wharf is of the flat slab and raker pile type. This design has perhaps gone a stage further. Some of the main piles are raker piles. The structure would, of course, be much stiffer if all piles were driven as raker piles.

Mourilyan Harbour Wharf

The wharf is of the flat slab type. It is 633-ft. long, 45-ft. wide, with projections on the inside to support the frames of the conveyor. Sugar carried on this conveyor belt is intercepted by the travelling gantry and discharged into the hold of the ship. There is no railway or tramway on the wharf, but two approaches are provided which will enable road vehicles to use the wharf.



CHARGING ROD & CHARGE ARE LOWERED THROUGH SANDPIPE TO DRILL HOLE ; ROD, SAND PIPE, ETC, ARE THEN WITHDRAWN.

Fig. 6 (top left); Fig. 7 (above); Fig. 8 (bottom left).

The loading requirements stipulate a ten-ton point load, a distributed load of 7 cwt, per square foot, and the reactions from the travelling gantry due to wind velocity of 130 m.p.h. The last mentioned load is 94 tons, but it is distributed over the wheels of the travelling gantry. Fig. 9 indicates the loading.

Piles

The piles are 18-in. x 18-in. square with a cover of 2½-in. to the main reinforcement which consists of 4 No. 1⅜-in. dia. M.S. bars. The ligatures are ⅜-in. dia. distributed at 6-in. centres throughout the length of the pile, but at 2-in. and 3-in. centres at the head and toe where the maximum driving stresses occur. The pile is fitted with a heavy steel shoe.

Close borings taken over the site determined that the piles would penetrate firm clay and decomposed rock up to 20-ft. Two timber test piles were driven to determine the bearing capacity

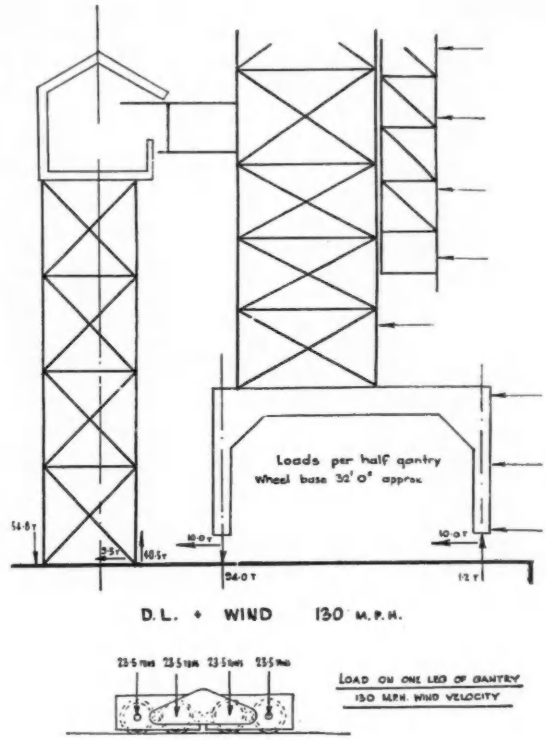


Fig. 9.

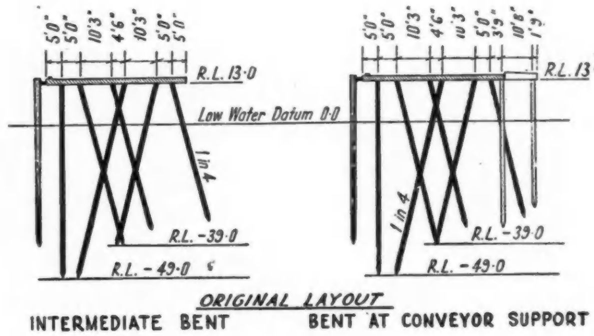


Fig. 10.

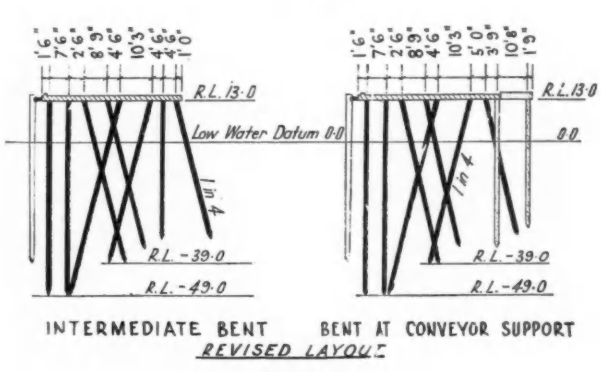
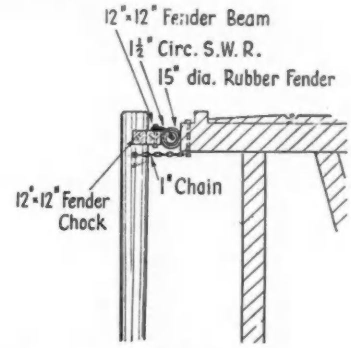


Fig. 11.



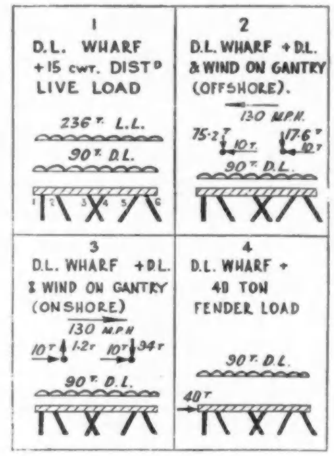


Fig. 12 (above) Fender System.
Fig. 13 (right) Load System adopted for Analysis of Pile Loads—Mourilyan Wharf.

TABLE I

PILE LOAD ANALYSIS—ORIGINAL LAYOUT.

Pile group	Load systems				Maximum pile loads	
	1	2	3	4	+	−
1	+60.0	+61.1	− 8.2	− 0.5	61.1 (2)	8.2 (3)
2	+50.0	+31.2	+ 2.4	+35.5	50.0 (1)	0
3	+46.9	+13.7	+26.0	+39.0	46.9 (1)	0
4	+63.3	+53.0	+31.9	−16.7	63.3 (1)	16.7 (4)
5	+70.2	+37.2	+60.1	−14.8	70.2 (1)	14.8 (4)
6	+42.4	−12.4	+59.5	+47.2	59.5 (3)	12.4 (2)

+ Indicates Compression, − Indicates Tension. All loads in tons.

TABLE II

PILE LOAD ANALYSIS—REVISED LAYOUT.

Pile group	Load systems				Maximum pile loads	
	1	2	3	4	+	−
1	+44.8	+39.2	+ 4.0	+ 6.9	44.8 (1)	0
2	+43.2	+34.0	+ 9.6	+ 7.1	43.2 (1)	0
3	+38.4	+27.3	+19.5	+11.9	38·4 (1)	0
4	+36.1	+20.6	+18.8	+12.2	36.1 (1)	0
5	+44.4	+26.1	+23.6	+ 9.5	44.4 (1)	0
6	+50 1	+20.2	+36.9	+11.8	50.1 (1)	0
7	+41.3	+ 9.4	+35.0	+ 9.2	41.3 (1)	0
8	+30.2	+ 2.7	+38.5	+13.1	38.5 (3)	0

Indicates Compression, − Indicates Tension. All loads in tons.

of the strata and the contractor will carry out test loads on the concrete piles. The maximum length of the concrete piles will be 64-ft. Five out of the six piles in the general cross-section of the wharf are raked at 1 in 4. The pile bents are at 15-ft. centres.

Design of Pile

The concrete strength for the work is specified at 4,000 lb./sq. in. at 28 days throughout. To date, however, strengths up to 6,000 lb./sq.in in 28 days have been obtained in the test cylinders. The mix is continually modified to keep the strength generally more than the specifications. The piles were designed from the long column formula using the S.A.A. Code CA.2, which allows 54 tons as the safe load on the pile. The Hiley Formula was used to determine the ultimate bearing capacity of the pile when driven.

Pile Driving

The contractors for the wharf, S. Haunstrup and Co. Pty. Ltd., have been granted permission to use a Demag diesel pile driving machine. The machine will be suspended from a 12-ton crane and the piles driven without leaders. This method will ensure that the piles are not constrained and therefore will not develop driving cracks. The problem of "set" has been determined from data supplied with the machine and from actual loading test, a test load of 112 tons having been applied to a particular pile.

Slab

As stated earlier, it has been evident from existing R.C. wharves in Queensland, some of which are over 50 years old, that the major deterioration and spalling has occurred in headstocks and secondary beams where there is a concentration of stress, and possibly also from the concentration of salt which causes corrosion in the reinforcement. This corrosion has been accelerated too by the smaller cover to the concrete and its relatively poor quality compared with modern standards. Various designs for the superstructure were considered and, because of its economy, mass, reduction in formwork, simplicity of reinforcement and ability to distribute heavy loads both vertically and horizontally, the flat slab was decided upon. The design generally follows the Australian Code CA.2 and British Code of Practice CP.114, but, because of the heavy loads from the mobile gantry, additional reinforcement forming a concealed continuous beam runs under the crane track.

The main reinforcement in the slab is ¾-in. dia. and, to cope with the maximum positive and negative bending moments, is at 6-in. centres. This forms a heavy grid over the piles and consequently no drops or heads are needed as the punching shear stress is relatively low. The amount of steel in the superstructure is 160 tons. A flushing slab averaging 4½-in. thick covers the wharf deck. All rails are therefore flush with the deck and drainage is fairly simple.

The concrete slab itself weighs over 4,500 tons, forming a huge mass countering the impact from the ship.

Fendering

In conformity with modern practice and other wharves recently constructed at Gladstone and Bundaberg, 15-in. dia. rubber fenders, 2-ft. long at 5-ft. centres, have been incorporated into the fender system. These are hung longitudinally behind a 12-in. x 12-in. timber fender beam connecting the fender piles which are at 10-ft. centres. The piles are held to the front of the deck slab with 1-in. dia. chain and are free to move transversely and longitudinally. Each length of rubber can compress 10-in. absorbing 44,000 ft. lb. energy in the process. Two such fenders would absorb the impact of a 10,000-ton ship moving at half a foot per second, which is the accepted condition for berthing vessels of this size.

Figs. 10 to 13 and Tables I and II show details of the wharf structure and fendering system, also load systems, pile tiers, etc.

The wharf is constructed so that it can accommodate the modern overseas cargo liner. The berth has been dredged to 34-ft. L.W.S.T., and if the rich cane fields in the district require it, then tankers will use the port for the discharge of oil products.

The contract for the wharf was given to S. Haunstrup and Co. Pty. Ltd. for the sum of £205,100, and was scheduled to be completed in October, 1960, by which date the entrance would be 26-ft. which would enable overseas ships of restricted draft to use the port.

N.B.—According to latest information (June 1961) the harbour is being used by tramp ships up to 480-ft. long. A tug is being used to berth the ships, although when the entrance dredging has been completed and ships are leaving more deeply laden, it will no doubt be desirable to use a tug to pluck the ship off the wharf and steady her before proceeding out through the entrance.

Lightly laden inbound ships are not presenting any problem, but a deep ship so close to the entrance when outward bound will probably need the assistance of a tug.

Part II.—Mourilyan Harbour Model

By G. R. McKAY, B.Eng., Ph.D., M.I.E.Aust.
(Reader in Civil Engineering, University of Queensland)

The Problem

Mourilyan Harbour is situated some miles south of Innisfail, North Queensland. The coast line in this area is made up of a series of short ridges running N.W.-S.E., diagonally to the coast. At Mourilyan, the sea has sometime broken through between two of these ridges flooding the valley behind. At present, the harbour area is about one square mile in extent but much of it is relatively shallow. However, immediately landward of the entrance there is a deep hole, in places over 70-ft. below low water, and there is useful water of about 1,200-ft. dia. about this hole.

The entrance, at the north-east corner, is narrow and shallow. The shallow portion of the entrance where depth is only 18-ft. below low water is, however, limited in extent and within a short distance on both the sea and land sides, depths of 40-ft. are encountered (Fig. 1). It appears to be the top of a sharp rock ridge. The entrance is constricted by rocky projections on either side.

The harbour was used largely by lighters which carried sugar from the three nearby mills to Cairns for shipping. The difficult and restricted entrance has limited the development of the port.

The estimated saving in freight charges on sugar alone justifies quite large expenditure in the development of the port. The general benefit to the rich agricultural area around Innisfail of such a port would be inestimable.

The hesitancy in opening the harbour entrance has arisen, not from the difficulty of the rock excavation necessary, but from the fear that opening the entrance would affect, detrimentally, conditions within the harbour even to the extent of ruining the present limited facilities.

Borings taken over the harbour showed that the shallow areas comprised alluvium to a considerable depth. It was generally agreed that the useful water, the deep hole, was in some way linked to the entrance conditions. Many and varied were the opinions as to how the entrance conditions caused the hole. There was a danger that changing the entrance conditions would

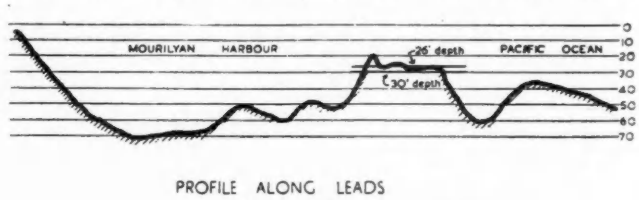


Fig. 1. Entrance to Mourilyan Harbour.

destroy the agency responsible for the scour, would lead to siltation and reduce depths everywhere to those of the shallower areas.

The University of Queensland, Department of Civil Engineering was asked, therefore, to build a model to investigate the problem. In particular, they were to determine:

(1) The reason for the existing formation.
(2) The effect on the existing formation of cutting a readily navigable channel through the entrance.

The Model

The model was built to cover the whole of the harbour area approximately 6,000-ft. x 5,000-ft. with the sea and entrance in addition (Fig. 2). The streams and their capacity would be

negligible compared with that of the harbour. Flow representing freshes from these streams could be added if required.

In view of experience with the Fitzroy River Model, it was decided to build the model throughout in erodable material, fixing only the known rock formations. To avoid difficulty in selection of material of construction, the design was based on the work of Lacey, Blench and King.

Choice of Scales

This work was carried out primarily to allow the Indian Irrigation Service to design stable channels in alluvium. It was shown by examination of existing works, that there was a relation

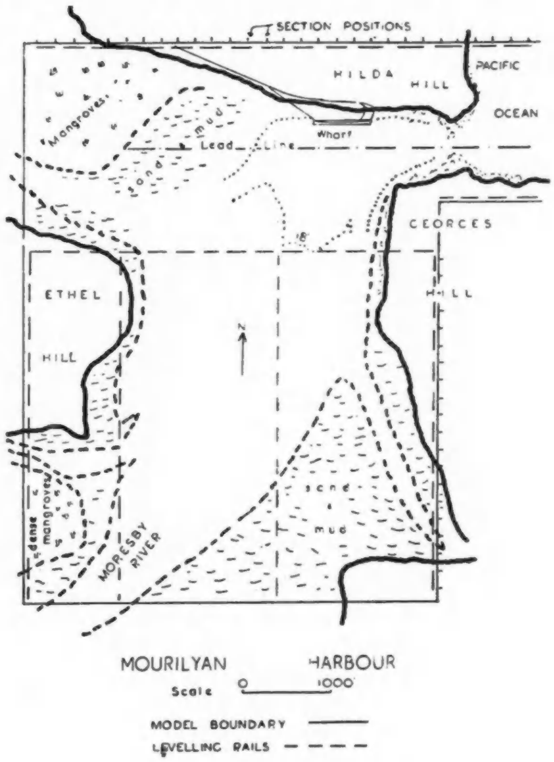


Fig. 2. Mourilyan Harbour.

between velocity, stable channel shape, slope and the alluvial material in which the channel formed. The results were ultimately summarized in the form:

$$D = bV^2$$
$$W = sV^3$$

when D is the depth
W is the width
Q is the discharge
V is the velocity
S is the slope
b = bed factor of the material
s = side factor of the material.

These relationships are true, within limits, irrespective of size. Thus, if subscript p refers to prototype and m to the model:

$$\frac{W_p}{W_m} = \frac{s_p V_p^3}{s_m V_m^3}$$

but $\frac{W_p}{W_m} = x$ the horizontal scale

and $\frac{V_p}{V_m} = \sqrt{y}$ the vertical scale.

Therefore, $x = y^{3/2}\,\frac{s_p}{s_m}$

If the same material is used on the model as that existing on the prototype, then:

$$s_p = s_m$$

Therefore, $x = y^{3/2}$

A model built in the same material as the prototype will react to silt movement in the same way as the prototype if this scale relationship is maintained.

The scales chosen for the Mourilyan Harbour Model were:

Horizontal scale $x = 200$
Vertical scale $y = 36$

which approximate closely to the requirements of distortion and form a balance between size and cost and ease of handling. The model harbour was approximately 40-ft. x 30-ft. with entrance and sea areas in addition.

All other scales are dependent on the choice of vertical and horizontal scales. The time scale T_R is determined from:

$$\text{velocity} = \frac{\text{length}}{\text{time}}$$

and also from velocity of flow $\propto$ head$^{\frac{1}{2}}$

Thus, $\frac{V_p}{V_m} = \frac{W_p}{T_p} \cdot \frac{T_m}{W_m} = \frac{x}{T_R}$

and $\frac{V_p}{V_m} = \sqrt{\frac{D_p}{D_m}} = y^{\frac{1}{2}} = 6$ (Ratio of velocities)

thus $\frac{x}{T_R} = y^{\frac{1}{2}}$

$$T_R = \frac{x}{y^{\frac{1}{2}}} = \frac{y^{3/2}}{y^{\frac{1}{2}}} = y$$

Thus the tidal period ($12\frac{1}{2}$ hours approximately) is given by:

$\frac{12.5 \times 60}{36}$ minutes = 20 minutes 50 seconds on the model.

Discharge scale Q_R is given by:

$$\frac{Q_p}{Q_m} = \frac{D_p W_p V_p}{D_m W_m V_m} = y^{3/2}x.$$
$$= x^2 = 40{,}000.$$

Tidal Mechanism

The tides on the model were produced by the Tide Machine designed by the Engineering Departments of the University for the Fitzroy River Model. This machine comprises three parts:

1—The Tide Synthesiser

The basic theory used is the Admiralty Prediction of tides. It is assumed that the tide curve is the resultant of a number of sinusoidal curves, whose periods are determined by the periods of the tide raising forces.

Thus $y = A \cos (at + \alpha) + B \cos (bt + \beta) + C \cos (ct + \gamma) \ldots$ where y is the height above M.S.L. and $A \cos (at + \alpha)$, $B \cos (bt + \beta)$, etc., are the component tides.

Of each tide, A, B, C, etc., is the amplitude or semi-range. a, b, c, etc., are the speeds when:

$$T_a = \frac{360}{a},\ T_b = \frac{360}{b},\ T_c = \frac{360}{c}$$

are the periods of the components. α, β, γ, etc., are the initial phase angles of the components at some arbitrary starting time.

There is a great number of actual components to make up a tide but many can be split into two further components having the same effect, and all components of the same speed can be resolved into a single component. By this mathematical device, an accurate tide can be computed from six components.

The tide synthesiser, Fig. 3, is simply a device to add mechanically the components $A \cos (at+\alpha)$, $B \cos (bt+\beta)$, etc. The periods, hence the speeds of the tide components, are the same

throughout the world. Two series of six eccentrics are driven through a gear chain at their correct speeds. The relative speeds of the components will always be the same, a function of the gear train. The actual speed is a function of the model scale. A completely variable gear box set between the synchronous motor and the gear train allows the sun eccentric to be driven at its correct model speed, whence all the other eccentrics will be rotating at their correct actual speeds.

A steel tape is fixed at both ends passes over each eccentric in turn and also under a pulley on the end of a heavy lever arm which keeps the tape taut. As the eccentrics rotate, the movement of the end of the lever arm represents the summation of the vertical movement of the eccentrics and hence

$$A \cos (at + \alpha) + B \cos (bt + \beta), \text{ etc.,}$$

and hence the actual tide.

While the periods of the components are the same throughout the world, the effect or amplitude of the components varies from place to place. The Department of Harbours and Marine supplied continuous automatic tidal records for Mourilyan Harbour. From these, a period 11/10/54-9/11/54 was used to make a harmonic analysis and so determine the amplitude and phase angles of the components at Mourilyan.

Tidal Analysis

The method employed was that described in The Admiralty Tide Tables, Part III—Instructions for Predicting Tides and for Analysing Observations, by A. T. Doodson, D.Sc. and H. D. Warburg, Commander R.N.

The results were:

Height of mean sea level above gauge datum (Indian Ocean datum) 4.24-ft.

		semi range (ft.)	phase angles
M_2		1.66	287°
S_2	(sun eccentric)	1.13	253°
N_2		0.67	272°
K_2		zero	
K_1		1.01	180°
O_1		0.46	155°

Each set of eccentrics on the machine is identical except that one side is displaced 90° from its corresponding eccentric on the other.

$$d\left(\frac{A \cos (at - \alpha)}{dt}\right) = -aA \sin (at + \alpha)$$

$$= aA \cos (90^\circ - at + \alpha)$$

The differential of a function with respect to time is the rate of change of that function. Thus, by setting the eccentrics on one side of the machine, each to its calculating throws M_2, S_2, etc., the end of the lever arm gives the actual model rise and fall of the tide. By displacing the eccentrics 90° and multiplying the semi-ranges by the speeds and using the product as the throw, the movement of the lever arm on this side then measures the rate of rise of the tide.

To each lever arm was fitted an electronic measuring device: on the rise and fall side a capacitance; on the rate side a potentiometer. These electronic devices feed electrical signals into the second part of the Tide Producing Machine — The Electronic Controller.

The Electronic Controller

This controller is essentially a servo mechanism designed and produced in the Electrical Engineering Department and a full description of the circuits used is reported elsewhere. The controller accepted and registered the signals from the lever arms correctly, both in amount and direction, and translated these signals into the automatic opening and closing of the control valve. In operation, a manual control allowed the water surface to be brought near to the capacitance head with which it then formed a capacitance. On switching to "automatic," any difference in the gap distance between the water surface and the capacitance head, and the "correct" distance, is translated into a signal which opens or closes the valve to correct the error. With the rate signal as the major signal and the capacitance as a fine over-riding signal, the water moves up and down with the capacitance head and at a fixed distance below it. Under normal working conditions the water surface does not vary more than two-hundredths of an inch from the mechanical movement of the lever arm.

A fine adjusting screw on the connection between the lever arm and the capacitance head allows simple setting of the Mean Sea Level to the correct level referred to the datum of the Model.

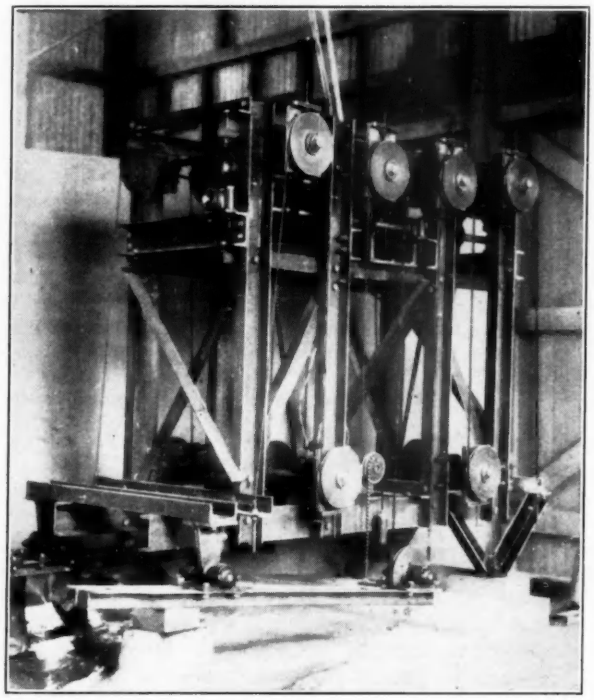


Fig. 3. Tide Synthesiser.

The Control Valve Circuit

This circuit shown diagrammatically in Fig. 4, is the third part of the Tide Producing Machine. The centrifugal pump *B* pumps continuously in one direction through the four-way valve *A*. With the valve diaphragm in position (a), water is taken from the storage and delivered to the model. By simple rotation to position (b) water is withdrawn from the model and delivered to the storage. Discharge is controlled by the position of the diaphragm between positions (a) and (b). The valve is motor-operated, the reversible motor being operated by the controller so that at any moment just sufficient flow is passing into or out of the model to maintain that water level dictated by the tide synthesiser.

Construction of the Model

The model was constructed on a lightly reinforced concrete slab with brick walls about 3-ft. high at chosen boundaries. Where convenient, angle irons were fixed rigidly to the brick walls and carefully levelled. Light deep trusses of Dexion angle were constructed and cross braced to each other. Double angles were suspended from the trusses and, by means of adjusting screws,

carefully levelled to the same level as the angles on the boundary wells. The span between the levelled rails was not more than nine feet. At this span, the deflection of double Dexion angle is of negligible order.

The level of the rails was set at 7½-in. (Model) above Indian Ocean Datum. Cross sections, on the lines shown in Fig. 2 were taken from the survey—Mourilyan Harbour, November, 1954, supplied by the Department of Harbours and Marine and plotted to the correct model vertical and horizontal scales on flat galvanised iron sheet. From these cross sections, the male section was cut out with the top of the section at 9-in. (Model) above Indian Ocean Datum. Each section was mounted between double Dexion angles with the top edge of the section flush with the angle leg. The short leg of a Dexion angle is 1.67-in. so that when the mounted section was placed in its correct position on the levelling rails, it was also at its correct level.

The model was filled with river gravel and topped with an alluvial loam. In all, about one hundred tons of filling were required. The loam was carefully moulded up to the suspended sections, which were then removed and stored in order. While

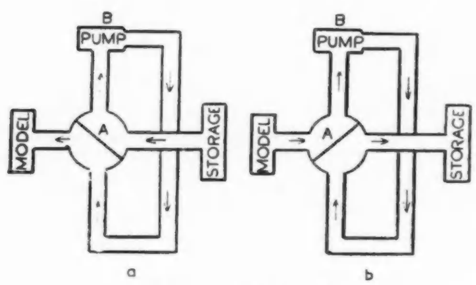


Fig. 4. Control Valve Circuit.

this method of moulding is possibly more tedious and less accurate than moulding to female sections, the levelling base (the rails) were undisturbed by changes on the model and allowed any further mouldings to be carried out quickly and without the necessity for re-levelling. The accuracy of the moulding attained at these scales would be, despite the difficulties, as accurate as the survey.

Some considerable difficulty was encountered in the initial moulding. This stage of construction was reached in December, 1955. For convenience of bringing in the material, moulding commenced at the sea and was worked through the entrance, the deep hole and back into the shallow area and adjoining marshes. As it was in the open, it presented, when nearing completion, quite a large catchment and the summer rains repeatedly caused large flows into the deep hole and sea portions, destroying all the efforts of moulding. Considerable assistance was given by the Department of Harbours and Marine to cover the model temporarily and allow completion of the moulding. However, the combination of wind and rain invariably destroyed these efforts and the cost of the large spans required excluded attempts at more permanent structures. Eventually, with the coming of autumn, the moulding was completed and danger of rain damage was negligible. The whole model could now be flooded to prevent such damage.

Areas of rock outcrop or non-erodable material were fixed on the model by wetting the surface and dusting with a mixture of Portland cement and cement fondu, a mixture which hardens very rapidly and is sufficient to prevent any erosion.

After the first moulding, details were added from supplementary surveys made by the Department of Harbours and Marine.

A general view of the model with tide synthesiser in position is shown in Fig. 5.

Model Observations

There was little measured information available to check the behaviour of the model. In fact, it is difficult to suggest what other information would be required. Surface float measurements had been made (Mourilyan Harbour Tidal Currents). Floats on the model traced out similar paths and as nearly as could be estimated at the right order of corresponding velocities at corresponding stages of the tide. Surveyors, ship masters and others who knew the harbour well all expressed the opinion that the model appeared to be reproducing the known prototype conditions. No one was able to point out any discrepancy between the model's behaviour and that in the prototype.

The tide synthesiser was set in approximately the position corresponding to the automatic tide gauge (see Fig. 5). The tidal heights were checked and were found to reproduce the known characteristics of the actual tides, the large daily components occasionally blotting out a tide during neaps and making successive tides very different in range.

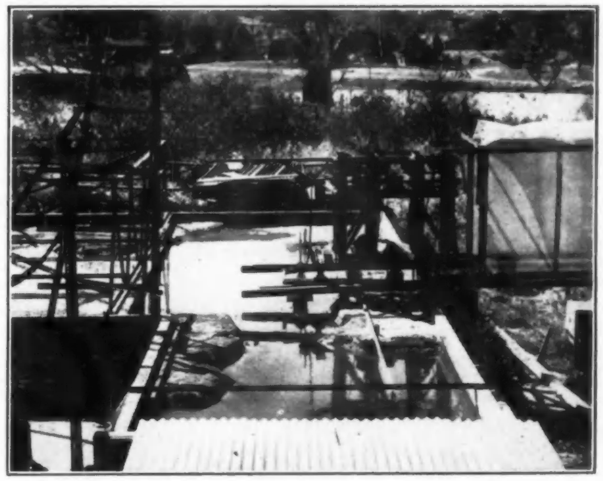


Fig. 5. General View of Model with Tide Synthesiser in position.

In the first observations, nothing was found which could reasonably be assumed responsible for the existing harbour formation. While the surface floats conformed in general to some sort of pattern, the currents they indicated were not, except through the entrance, which is rock, intense enough or consistent enough to suggest they were responsible for or a result of the formation of the hole.

It was decided to investigate subsurface velocities to compare them with the surface currents and also to find the variation in current at a particular depth with the stage of the tide. Loaded balsa wood floats were made to the same pattern as those actually used by the Department of Harbours and Marine Surveyors. The base of the float contains virtually all the drag area. The stem acts only as an indicator of depth and position.

Float Tests

A whole range of floats was made, about six in number of each, and loaded to submerge to 4, 6, 8 . . . 26-ft. At first, a 4-ft. float was introduced just outside the harbour entrance on the lead line every hour (for clarity all dimensions are referred to the actual harbour) and its course and behaviour noted. A tide cycle, 29 tides, required approximately a full working day on the model. These tests were, therefore, very drawn out and tedious and, as they were revealing nothing unusual, were subsequentlly abandoned in favour of introducing quickly one after the other at half tide one float each of 4, 6, 8, etc., up to about 26-ft.

It was then found that floats in the lower layers of the entrance flow were sometimes drawn down as they passed through the entrance, many of which only re-appeared on the far side of the deep hole. Meanwhile, floats not in the lower layers passed into the harbour and showed no signs of being drawn down.

Extensive tests were carried out with these balsa wood floats in the lower layers and revealed that, during the spring tides on the incoming tide, a current developed at the harbour entrance, remaining under the main body of water in the harbour and passing across the floor of the deep hole in the harbour. It was also noticed that on the outgoing tide a similar current developed, perhaps not so intensely, on the seaward side of the harbour entrance.

A study of the profile along the lead line shows an amazing general similarity of form inside and outside the entrance. At this stage it was reasonable to assume:

(1) The current was responsible for the scour formation.

(2) The current was a function of the shape of the harbour entrance.

As fresh water of the same temperature was being used, the possibility of density currents could not arise.

If these assumptions are true, it would follow that the formation of the hole was a function of the shape of the harbour entrance, a conclusion which carried significant implications.

It was essential therefore to determine:

(1) The correctness of the model so far as the development of this current was concerned.

(2) A relationship between intensity of the current and the harbour entrance shape.

(2) The effect of the current in relation to scour.

If (1) was established, it would then be possible to obtain a very clear picture of the effect of widening and deepening the harbour entrance.

The Department of Harbours and Marine investigated the flow conditions at the harbour entrance and did establish the development of the currents indicated on the model. The currents were strong but, with the facilities available, it was not possible to obtain actual measurement of velocities.

On the model, it was found equally difficult to measure the intensity of the current. In the first place, it is difficult to define "intensity of the current." From the float tests, it appeared that sometimes the current developed and carried the float down but the float quickly re-appeared, either because it had escaped from the current or the current had dissipated. At this stage the water in the harbour was always murky. Even when the whole system had been cleaned out and re-filled with clean tap water the murkiness persisted. As a result, it was not possible to see the floats beyond about one foot below the surface. At first, it was thought that the murkiness was a result of moulding the model in alluvial silt. For other experimental reasons we could not consider sealing the model. However, during the continuous float tests it was noticed that the harbour became appreciably clearer during neap tides. The murkiness was to some extent the result of the disturbing action of the tides. It was considered to make a measure of the murkiness a measure of the intensity of the current, but the difficulties of establishing a standard of comparison appeared insuperable and this idea was also abandoned.

Were it possible to see the floats, it would have been easy to measure the horizontal components of velocity, but owing to the distorted scale of the model, the vertical movement of the float was of the same order as the horizontal and we could not devise a method to measure this vertical movement.

A miniature current meter was fabricated. This instrument has a 1-in. dia. rotor and was designed to swing into the direction of maximum velocity. As it was not possible to see the rotor to count visually the revolutions, a tiny coil, 5,000 turns of 50-gauge wire, was built into the head. As the rotor cups passed the coil, a current was induced in the coil which could be detected on a galvanometer, and thus allow the counting of the revolutions of the rotor. However, despite the use of jewelled bearings, the instrument would not record below about 4-in. per second, which appeared to be about the maxium value of the current.

Attempts were then made to measure the effect of current directly as a scouring agent. Material was added to bring the bottom of the hole up to 50-ft. below datum. It was hoped that, by running the model continuously through many tide cycles, it would move the material and the amount of movement would be a measure of the current. However, despite the use of many types of silt, including a very fine ooze dredged from the Brisbane River and supplied by the Department of Harbours and Marine, in no case did any scour take place. On the contrary, the surface appeared to be padded down to form quite a hard layer about 1-in. thick.

That no movement occurred did not necessarily prove that the scouring action of the current would be nil on the prototype. It is an unfortunate fact that there is a minimum velocity required to lift silts and this minimum velocity would be the same on the model as in the prototype. The corresponding velocities on the model are considerably less than those on the prototype. Two feet per second could cause considerable movement whereas four inches per second, being below the minimum velocity to move silt, would cause no movement whatsoever.

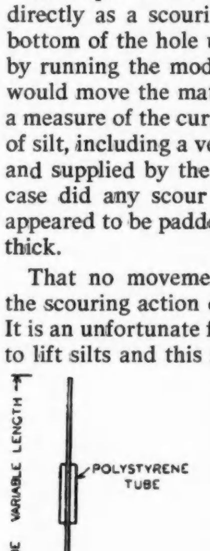


Fig. 6. Polystyrene Float used in Model Tests.

Ultimately, comparative effects were obtained by the use of floats. The balsa wood floats used previously were affected by moisture content and the balance varied radically from time to time. A new set of floats was made. The base, 1-in. dia. x ½-in., was made from Polystyrene, a completely impervious plastic, which has a density of only 1.07. A central hole was drilled and sealed to make the nett density of one. The stems were of 0.05-in. dia. aluminium tubing loaded with fine wire, again to give a nett density of one. A set of floats comprised a float reaching to 22-ft. depth with the tip of the stem just in the surface, a float reaching to 22-ft. depth with one inch protruding from the surface, a float reaching to 22-ft. depth with two inches of stem protruding, and so on. Each float was therefore just a little more buoyant than the preceding one; but as the stem had a density of one, it would be weightless in water and the buoyancy remained unchanged as the float was drawn down by the current.

This type of float suffered one disadvantage. The first float was so weightless in water it would float in any direction. If, on inserting it into the flow, it went in at an angle, it stayed at that angle and the base was not in the lower layers. To correct this fault, a tube of ¼-in. dia. polystyrene was set high on the stem, and the buoyancy of this tube counteracted by loading the base with fine copper wire. This polystyrene tube would induce some drag on the float other than on the base but it was so small compared with the base, it was considered that the float would still indicate the behaviour in the lower layers. The final design of float is shown in Fig. 6.

The downward drag of the current would be counteracted by the buoyancy of the floats. That float whose buoyancy was just

too big to be drawn down would be a measure of the current intensity. As the current intensity dissipated, as it moved across the harbour, it would be unable to hold the float and so the point of re-appearance would be some measure of the persistence of the current.

These tests were carried out over a wide range of tide cycles. At half-tide on the rising tide the floats were put in the flow just outside the harbour on the lead lines. The time to pass through a measured foot in the entrance was taken and the subsequent behaviour of the float noted. A typical result sheet is given in Table I.

Movement of Floc

When the tests were completed for the existing entrance conditions (18-ft. at low water) the entrance was widened to 220-ft. on the line given by the Department of Harbours and Marine and deepened successively to 24-ft., 26-ft., 28-ft. and 30-ft. and for each depth the tests were repeated with floats built to suit that depth and with the base placed in the same relative position to the bottom of the entrance.

The results are summarised in Fig. 7. They are clearly illustrative of the effect of the deepening, although no hard and fast relationship between entrance velocity, height of tide, etc., can be established. It was clear that as the entrance depth was increased, the number of tides on which the floats were pulled down was progressively less until at 30-ft. it was only on the occasion of a very high tide that any current at all developed.

At 26-ft. the currents were still well-developed on the spring tides. At 28-ft. there was a noticeable weakening of the currents. At 30-ft., as has already been stated, the vertical currents had virtually disappeared. It can be seen that deepening to 26-ft. still leaves some of the ridge-like formation of the entrance. Deepening to 30-ft. on the other hand requires considerably more excavation in proportion and leaves a long channel into the harbour. While it is not always apparent from the measurements, the effect of widening and deepening could be observed to reduce considerably the high local velocities and navigational hazards. The minimum distances over which the floats could be timed with any accuracy on the model was one foot which represents 200-ft. in the actual harbour. The constriction in the entrance is limited

TABLE I

No.	Low tide height	High tide height	Float buoyancy 0	Float buoyancy 1 in.	Float buoyancy 2 in.	Time over 1 ft. in entrance (secs.)	Av. velocity over measured distance (ft./sec.)
1	0′ 9″	8′ 3″	down	down	just down quickly re-appeared	2.2	2.7
2	2′ 7″	5′ 0″	down	just down quickly re-appears	slight movement under surface	3.2	1.9
3	0′11″	8′ 0″	down	down	down below surface	1.6	3.75
4	3′ 1″	5′ 0″	down	not drawn down	not drawn down	4.0	1.5
5	1′ 1″	7′ 3″	down	down	down but reappears ½ way into harbour	2.2	2.7
14	3′ 6″	5′ 4″	not down	not down	not down	7.0	0.85
15	3′ 9″	4′ 6″	not down	not down	not down	10.0	0.6

in extent, and it was clear that the variation of the maximum velocity within the measuring distance from the average velocity at an 18-ft. depth was considerable, whereas with the greater depths the maximum and the average were much the same thing.

In addition, the cross sweep, so apparent under existing conditions, was largely eliminated with the widening and deepening. A subsidiary set of tests was carried out to see if the entrance change would alter tidal conditions in the harbour. Simultaneous readings were taken inside and outside the harbour. As the tide machine was set up in the harbour and impressed the tide on those waters, any change would be detected as a change in tide outside the harbour. Allowing for the normal error of two people taking simultaneous pointer gauge readings on a rapidly changing surface, no change could be detected.

Movement of Floc

In an attempt to obtain more conclusive results from the model, instead of using clear tap water, raw water from a lagoon in the University grounds was pumped into the model harbour. It was made slightly alkaline by the addition of sodium silicate and the finely divided particles were precipitated as a floc by the addition of alum. To obtain a reasonable depth of floc it was necessary to syphon off the water, add more raw water and repeat the precipitation a number of times. Great care was necessary when

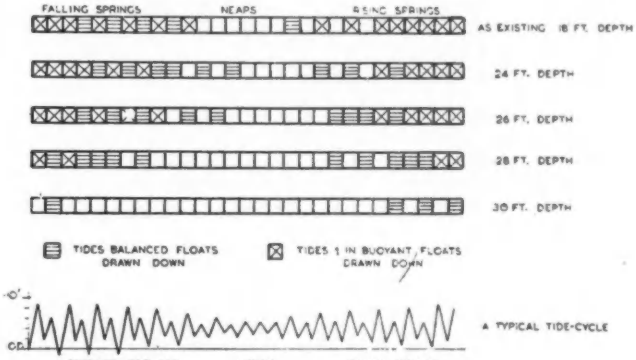


Fig. 7. Behaviour of Floats of Different Buoyancies illustrating the Effect of Deepening of the Harbour Entrance.

adding subsequent changes of raw water not to disturb the floc already in the bottom of the deep hole. When sufficient floc was laid, the system was filled with clean water and the harbour now remained quite clear. The floc moved with the slightest disturbance so the whole effect of the current and deepening the entrance could be observed quite clearly.

Again, however, it was not possible to obtain any precise measurements. The movement of the floc is like that of a cloud. The movement of any particular particle at any moment bore little relation to the general movement of the whole. While the movements were so easy to observe, they were equally difficult to record. A film was taken of the movement of the floc. Despite difficulties of reflections and shadows, the film shows the movement but, as the movement is not automatically combined with the stage of the tide, it loses its value as a technical record.

The observations with the floc confirmed exactly the conclusions of the float tests. Under existing entrance conditions, a vertical current develops in the harbour on all but the low neap tides. As the entrance is deepened, the current develops on fewer and fewer tides until at 30-ft. it occurs only on rare occasions.

In addition to confirming the results of the float tests, the experiments with the floc allowed the movement of the particles to be traced. When the current developed it swept right across the floor of the deep hole. It caused considerable disturbance and brought a lot of the floc into suspension. Some was carried across the floor up the west side of the hole and was deposited on the west side of the harbour opposite the entrance if somewhat south of the lead lines. As the tides reached high water, the floc in suspension began to subside but a small amount remained long enough in suspension to be carried out to sea on the ebbing tide.

It is a known fact that while a small velocity, say one foot per second, is insufficient to pick silt up and carry it, that same velocity will carry the silt once it is in suspension. It would appear, therefore, that the process which is taking place in

Mourilyan Harbour is the development on some rising tides of a vertical current. This current is of sufficient intensity to bring into suspension any silt in the harbour bottom adjacent to the entrance and allow it to be carried by the normal tidal flows. Some will be deposited on the banks of the west side of the harbour and a small amount possibly carried out of the harbour on the ebb tide.

A study of Harbour and Marine soundings of the harbour reveals a slight deposit of material in the position indicated by the model.

While the model revealed the cause of the scour, for these results to be of practical value they must be read in conjunction with the potentiality of the harbour to silt up.

Samples of the harbour water have been taken at regular intervals since November, 1956, and analysed for solid content. A sample result is given in Table II. The solid content is always very small and even this small amount appears to be largely organic.

Conclusions

It can be reasonably concluded, therefore, that silt movement into the harbour is always very small. If, therefore, the scouring action develops sometimes, it should be sufficient to maintain the existing harbour formation. If the entrance were deepened to 26-ft., it is probable that no change in the formation would take place. This may also be true at 28-ft. At 30-ft. it is likely that deposition will exceed the scour but the deposition would be very slow and it would be a long time before any detrimental change would be effected.

TABLE II

SOLIDS IN SUSPENSION IN MOURILYAN HARBOUR.

Sample	Date	Wt. of solids in 250 cc.	P.P.M.	Remarks
1	5.11.56	0.04	160	
2	13.11.56	0.01	40	Pale brown colour very difficult to filter.
3	20.11.56	0.005	20	
4	27.11.56	0.04	160	
5	4.12.56	0.04	160	
6	11.12.56	0.01	40	
7	18.12.56	0.005	20	Half ebb tide 4′ 4″.
8	22.12.56	trace		
9	2. 1.57	0.02	80	
10	3. 1.57	0.005	20	
11	4. 1.57	0.005	20	Strong smell.
12	5. 1.57	0.035	140	
13	7. 1.57	trace		
14	10. 1.57	trace		Deep green difficult to filter.
15	12. 1.57	0.025	100	
16	17. 1.57	0.01	40	
17	18. 1.57	trace		

Trade at Port Churchill in 1960

Fewer Ships on the Hudson Bay Route

In accordance with their terms of reference, the Commonwealth Shipping Committee under the chairmanship of Sir Clement Jones, have again examined the conditions affecting ships trading to Port Churchill and details of the trade in 1960 are given in their 20th Report on Hudson Bay Marine Rates published last month.*

During the 1960 season, 48 ships made commercial voyages to Churchill and loaded grain cargoes totalling 19,582,500 bushels. The number of ships was 10 fewer than the record established in the 1959 season but the quantity of grain shipped almost equalled the 19,913,000 bushels loaded by 55 ships in the 1958 season and greatly exceeded the 1956 figures when the same number of ships (48) loaded 16,130,000 bushels.

The Report shows that shipping arrivals at Churchill were spread fairly regularly throughout the season and turn-round statistics compared favourably with those of the previous season. Reference is, however, again made to the delays to ships held at the anchorage waiting their turn for a vacant berth, but the Committee understand that the additional berthage facilities which are now under construction should be ready for use at the opening of the navigation season in 1962. They will assist the Master in carrying out the preliminary formalities that are necessary for his ship to be accepted as ready for loading.

The season of navigation extended, as it has done since 1955, from the 23rd July for ships passing Cape Chidley to the 15th October for ships leaving Churchill with an extension permitting ships to leave Churchill between the 15th and 20th October subject to a surcharge on the Scale rates of insurance. However, whereas previously Underwriters permitted vessels trading to Churchill in the early days of the season to pass Cape Chidley provided the Masters had received permission to proceed from the Canadian Government patrol ship, Underwriters varied this condition at the request of the Canadian authorities and the revised insurance condition which became effective for the 1960 season now reads:

> "No vessel may pass Cape Chidley prior to the 10th August unless the Captain has received advices from the Ice Information Officer stationed at Churchill or the Canadian Government patrol ship that it is safe to do so."

The Report states that the last grain ship left Churchill on the 12th October and records that although Underwriters approved the extension of the season of navigation from the 15th to the 20th October in 1955, no ships have ever made use of the facility. The Committee were informed, however, that at the end of the 1960 season, ice formed in Churchill River on the 17th October and navigation in the river officially ceased on the 18th October.

At the beginning of the season a number of the ships encountered ice fields and, after experiencing difficulty and delay in forcing passages, sustained ice damage. In the main, the damage was of a superficial nature, and all the ships concerned loaded their cargoes after undergoing repairs at Churchill.

The Report refers to the aerial surveys of ice conditions which were arranged by the Canadian authorities. Survey flights, which began before the season of navigation opened and continued until after the season closed, covered the shipping route through Hudson Bay and Hudson Strait from bases at Churchill and Frobisher. The aircraft based on Port Churchill made 24 reconnaissances of the Hudson Bay area between the 6th July and 19th November, 1960, and those based on Frobisher made 40 survey flights over the Hudson Strait area. Shipboard ice observers were assigned to six of the Canadian Government icebreakers whose duties included support to shipping on the Hudson Bay route and the observers completed a number of short-range helicopter ice reconnaissance flights as directed by the Masters of the icebreakers. Additionally, the reconnaissance aircraft based at Churchill and Frobisher gave tactical support as requested by the Ice Information Officer, Churchill, to the icebreakers and to commercial ships on 23 occasions. The Canadian authorities anticipate that the programmes of aerial surveys and support flights in 1961 will be generally similar to those undertaken in 1960.

At the end of the 1960 season the quantity of grain in store at Churchill was 4,851,000 and this amount will be held in readiness for the opening of the 1961 season.

*"20th Report on Hudson Bay Marine Insurance Rates 1961." Published by H.M. Stationery Office, price 1s.

Reinforced Plastics in Buoy Construction

The AGA Plastic Lightbuoy

In April, 1960, the Dock & Harbour Authority printed an article describing the development of the AGA Plastic Lightbuoy which had been laid by Trinity House in the North Sea some miles from the Coast off Harwich. This Buoy was on site for a continuous period of a little over one year, being eventually withdrawn on 13th February, 1961. It is felt that a further report on the performance of the Buoy in service, its condition upon withdrawal, and on recent developments with plastic lightbuoys, will be of interest.

During the trial the Buoy was subjected to many severe gales from which it emerged unscathed and reports received from Trinity House indicate that in normal weather the Buoy rode comfortably and reasonable upright. The Buoy was quite stable when two men went aboard during the trial period when a wind force of 5 to 6 prevailed.

The Buoy was lifted by Trinity House during the Summer of 1960 to examine it for marine growth after six months at sea, and it was found to be in a very clean condition. The waterline had a thin covering of green growth and the underwater body was covered with slime but there were no barnacles or mussels on the plastic parts, although small amounts were found on the metal fittings. The Buoy deck was clean and in general the opinion of Trinity House was that the growth was not as bad as would have occurred on their standard steel buoy during the same period. There was no indication of any deterioration whatever, and the Buoy appeared completely watertight.

After withdrawal from Station in February, 1961, the Buoy was returned to Beacon Works, Brentford, virtually untouched. for examination, and a number of Marine Authorities were invited to send representatives to examine it.

Of the people who saw the Buoy, who included representatives from Trinity House, Oil Companies, Lighthouse Authorities, and Consulting Engineers, those best qualified to offer an opinion remarked that the amount of marine growth was appreciably less than would have been expected on a steel buoy, and that the marine growth had had no detrimental effect upon the plastic components.

Fig. 1. The Lightbuoy showing marine growth after 12 months trial in the North Sea. Note clean appearance of the segment which was scraped down after withdrawal from sea.

R.A.F. Photograph—Crown Copyright Reserved.

Fig. 2. The Lightbuoy being lowered into the water at Gibraltar before being towed by the Pinnace. Note how the heavy chain bridle is lashed up at three points to prevent fouling the sea bed when leaving the quay and the 500-lbs. "Cope" anchor to the port quarter of the Pinnace.

The plastic buoyancy chambers were provided with drain plugs in the bottom and when these were opened, each chamber was found to contain some water. Subsequent examinations revealed that the water had entered through small cracks in the joints between the sides and the bottom of the buoyancy chambers due to the strain imposed upon the joint when the structure was bolted up. This possibility had been foreseen and on buoys made after this second prototype the design of the chambers had already been changed to eliminate any joints in this position. The latest chambers are moulded with the sides and the bottom in one piece.

Various methods of cleaning were tried, and it was found that the growth was most easily removed immediately after the buoy was taken from the sea. On this occasion a metal scraper was used but this was inclined to scratch the plastic surface, and it is considered that a hard rubber scraper is the best implement.

Clams left small patches of deposit firmly adhering to the plastic surface and these were removed with hydrochloric acid without detriment to the plastic. In practice, however, it is thought to be necessary only to scrape off any excessive weight of growth.

None of the buoyancy chambers was damaged in service, but on their return to Works two holes were made on the outside face of one, measuring approximately 2-in. dia. and 10-in. dia. and these were successfully repaired using glass mat and polyester resin. Experiments are now being undertaken to determine whether better results may be obtained using epoxy resin.

There was no sign of any slackening of the bolts securing the metal components and the sealing material protecting the nuts was well preserved and easily removed for dismantling the buoy. The metal components were in good condition, with little evidence of rust, and current policy is to galvanize them heavily. Experiments are being conducted, however, to investigate the possibility of coating these parts with other plastics.

As a result of this trial and the subsequent examination of the buoy it seems reasonable to conclude that having incorporated the modifications to the buoyancy chambers already described, it is capable of performing the duties for which it was designed.

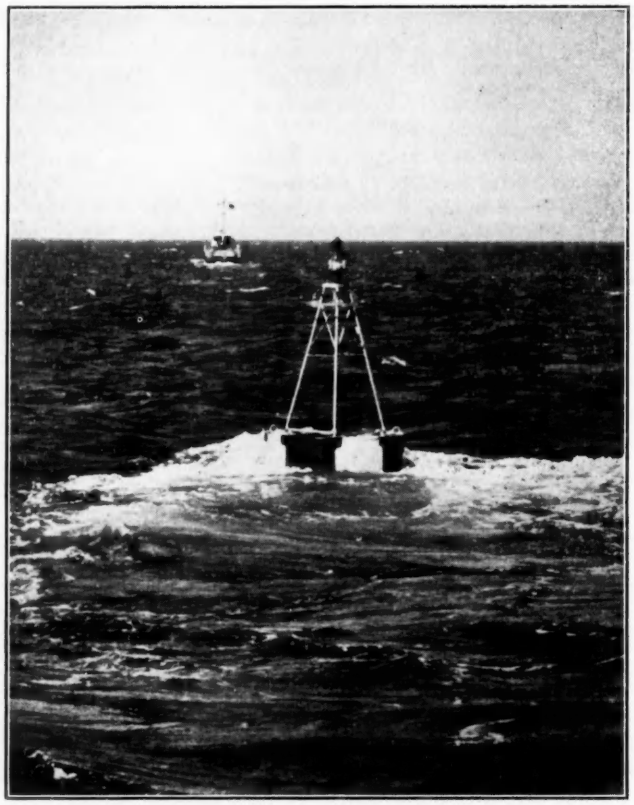
Further Developments

Experimental samples to determine the effect of tropical waters on the plastic materials have been sent to Harbour Authorities in Nigeria, the Persian Gulf, Malaya and West Indies.

Three plastic lightbuoys of a similar type have been manufactured for the Air Ministry and one of them was laid recently in the Mediterranean Sea some twenty miles from Gibraltar. There are two interesting features concerning this buoy which illustrate the advantages of the plastic buoy over the conventional steel type. Firstly, the buoy had been laid in a depth of 250 fathoms using nylon moorings and a 500 lbs. "Cope" anchor. This depth had been regarded hitherto as being well beyond the maximum depth of a steel buoy and moorings on account of the great weight of the chain.

Secondly, the buoy was towed to its station and laid using a 64-ft. Royal Air Force General Service Pinnace and it has been found by practical experience that the buoy can be towed quite safely and with little heeling at 7½ knots.

As as additional measure of safety in the event of the buoyancy chambers becoming holed due to accident or collision, the buoyancy chambers can be filled with a polystyrene foam. To keep the additional cost to a minimum a batch of six buoys recently ordered by the Air Ministry will have four of their eight chambers half filled with foam.



R.A.F. Photograph—Crown Copyright reserved.

Fig. 3. Towing the Plastic Buoy at 500-ft. at about 4 knots.

Summarizing, therefore, the advantages to be gained by the use of the AGA Plastic Lightbuoys are as follows:—

1. Ease of maintenance because the buoy can be laid and withdrawn from station with a motor launch.
2. Can be moored in great depths through the use of nylon ropes and high efficiently lightweight anchors.
3. Reduced fouling.
4. Ability to withstand rough sea conditions.
5. Operates unattended for one year using AGA acetylene gas lighting equipment.

The AGA Plastic Lightbuoy is expected to be of particular value to those smaller authorities who do not possess or could not afford a large buoyage vessel. Weighing only 2¼ tons complete with lighting equipment and accumulators but excluding moorings the buoy can be towed and even lifted by a small craft suitably equipped.

Change in Port of Bristol Management

Mr. F. D. Arney, the General Manager of the Port of Bristol, retired at the end of September last after completing 47 years service with the Port.

Mr. Arney can look back on a long and distinguished career with the Authority. He joined the staff as a junior clerk in 1914 and shortly afterwards served in France in the First World War as a Signaller in the Wiltshire Regiment. He was appointed Assistant Secretary in 1935 and Assistant General Manager in 1941, being personally responsible for all operational work at Avonmouth Docks in the Second World War. He has held the post of General Manager since October 1945, and during this time has been a member of a number of national bodies connected with the port industry. These include the Executive Committee of the Dock and Harbour Authorities' Association, of which he was Chairman for four years, and the Executive Committee of the National Association of Port Employers. He is also a member of the Milford Haven Conservancy Board, the National Joint Council for the Port Industry and the National Dock Labour Board.

Mr. F. D. Arney, C.B.E.

Since 1946 Mr. Arney has been Chairman of the Port of Bristol Employers' Association and Chairman of the Local Joint Council for the Port Transport Industry and in those capacities has made a notable contribution to the good labour relations which obtain in the Port. In the New Year Honours List of 1959 he was awarded the C.B.E. for his services to the Port Industry.

During Mr. Arney's term of office as General Manager the total tonnage of cargo handled by the Port has risen from just under 4¾ million tons to over 7½ million tons. During this same period £5½ million has been spent on new capital works and a further £5 million authorised for works in progress. This must be regarded by any standard as a remarkable period of progress in the history of the Port.

It has been announced that **Mr. G. Edney** has been appointed General Manager in succession to Mr. Arney. A native of Bath, Mr. Edney took the degree of Bachelor of Commerce at the London School of Economics. From 1949 to 1953 he served as Deputy Chief Accountant to the South Western Gas Board, joining the Port of London Authority as Deputy Chief Accountant in 1953. He was appointed Chief Accountant in 1955.

He is an Incorporated Accountant Member of the Institute of Chartered Accountants, a Member of the Institute of Costs and Works Accountants and a Member of the Institute of Municipal Treasurers and Accountants. During the last war he served in the R.A.F. from 1940 to 1946 rising to the rank of Squadron Leader.

I.C.H.C.A. Technical Conference in New York

Papers presented at General Assembly, September, 1961

Specially contributed

THIS, the fifth biennial Conference held by the International Cargo Handling Co-ordination Association, was attended by over 200 delegates from 24 nations. Part of its official business was to accept the resignation of the President, M. Rene Courau (France), who had held office for seven years.

Introducing the new President to the Technical Conference, M. Courau stated that he now saw I.C.H.C.A. emerging as an adult organisation. The number of national committees had increased to twelve; he was sure there would soon be more. He believed the Association was certain to succeed, if only because no other body existed to serve the same purpose.

The newly-elected President, Rear Admiral G. McLintock, who is also President of the U.S. National Committee, stated his determination that I.C.H.C.A. should fulfil its purpose and, particularly, play a useful part in the current revolution in cargo handling methods. His policy would be to see that more bodies and more people actively engaged in the handling of cargo were recruited to membership, that the Association's technical services were improved and that a high quality magazine was issued regularly.

Nine papers were read at the conference. They dealt with the following subjects: (1) packaging and preparation of cargo for export; (2) cargo marking; (3) economics of distribution costs in the construction of consumer prices; (4) union work rules and technological change; (5) Pacific coast waterfront mechanisation —the collective bargaining approach; (6) the port of the future; (7) cargo loss prevention; (8) cargo handling frontiers in civil aviation; and (9) certain basic cargo handling and shipping problems associated with port operations in emergent economies.

Each made a contribution to the work of the conference. Some —those, for example, on packaging for export, cargo marking and cargo loss prevention—were mainly concerned with bringing delegates up to date. Others were more controversial and that on "the port of the future" and those dealing with the industry's labour problems, were potential discussion provokers. The listed discussants on the port labour questions had much of interest to say upon the West Coast agreement between the Pacific Maritime Association and the International Longshoremen's Union, but there was little opportunity for rank and file delegates to enter the discussion. Extracts of the papers upon the more controversial subjects follow:

Union Work Rules and Technological Change

by M. D. KOSSORIS,
(Regional Director, Bureau of Labour Statistics, San Francisco.)

The speaker first referred to work rules applying in United States industry generally. It was when he reached the subject of collective bargaining that he turned his attention particularly to the port industry.

"Perhaps one of the most unique solutions arrived at thus far" he said, "is that developed by the Pacific Maritime Association (PMA) and the International Longshoremen's and Warehousemen's Union (ILWU) of the West Coast. The agreement between these two groups is sufficiently novel to warrant a brief description.

The ILWU practically has a labour monopoly of all longshoremen on the West Coast. Its membership in longshoring consists of about 15,000 longshoremen and clerks—the class A registered men. In addition, there are about 1,200 to 1,500 class B longshoremen and clerks from whose ranks the Class A men are recruited when necessary. There also are about 10,000 casual workers who move in and out of the industry without being definitely connected with it. The class B and casuals, despite their numbers, only account for 12 to 14 per cent of the total manhours worked in longshore operations. The class A men are considered the recognized labour force in this industry.

Beginning with 1934, the union has succeeded in imposing stringent work rules upon the employers in the West Coast shipping industry. Limitations were imposed upon the size of the load that may be lifted, the number of men in any given gang, the hours they may work, the mobility of the work force, the introduction of machinery and a variety of other work aspects. The proclaimed purpose of the union was to lighten the work for the men and to make work safe. Unofficially, union leaders will admit that another purpose was to provide more work for more men and to prevent speed up.

The warfare between the ILWU and the shipping industry was one of the stormiest in U.S. labour-management history. Management and labour fought at any and every provocation. It required governmental commissions and arbitrators to settle nearly every important issue. But the situation took a sharp turn after 1948, particularly during the late 50's, when the employer association changed its tactics from open warfare to an attempt to make the collective bargaining process work. By 1959, the relationship had reached the point at which the union was willing to discuss the possibility of surrendering its historic opposition to mechanization and its restrictive work rules—if management agreed to share with the union the gains that would accrue from this "modernization." The 1959 agreement gave the employers the right to proceed with unlimited mechanization without hindrance by the union. For this privilege the shipping companies paid 1¼ million dollars into a jointly trusteed fund. During the 1959-60 contract year, however, all work rules remained frozen. During this year also PMA was to come up with a method of measuring longshore performance so that the gains from improvements in longshore operations could be measured. The parties to the contract expressed as their intent the sharing of the gains that would result from such improvements.

I was employed by PMA to develop the measurement system, and did so. I was given a year's leave of absence by Secretary of Labour Mitchell from my position of Regional Director of the Western Region of the Bureau of Labour Statistics. The measurement system, however, still required the negotiating parties to

decide what portion of the savings was to be paid into the fund as the union's share. The ILWU asked for a straight hour's pay for every manhour saved. The employer's share would be the cost beyond straight pay—in 1960 the difference between $2.78 and about $4.15 per hour—and the faster turn-around time of ships. The value of this varied between $2,000 and $5,000 per day per ship for different ships and types of trade.

During the negotiations in the spring of 1960, the purposes of the fund were settled. There were to be no layoffs. The work force would be permitted to decrease automatically by about 4 per cent a year because of retirements, deaths and drop-outs. No new men were to be added except by mutual agreement. An annual wage of 35 hours per week at straight-time pay was guaranteed. Every class A longshoreman was to receive $7,920 upon reaching age 65 with 25 years of service. This could be paid in monthly instalments of $220 per month at ages 62, 63 or 64 if the man with 25 years of service retired voluntarily. If he was forced to retire so as to curtail the available labour force, the monthly stipend was increased to $320. If the man died before completing 25 years, his dependents were to receive life insurance, escalated to years of service.

The annual guarantee, however, was to hold only to the extent that the lessened requirements for labour were attributable to the modernization programme. It would not hold if depressed economic conditions brought about a slump in the volume of cargo. The employers agreed that the charges should not result in speed-up and in making the work "onerous."

The employers, however, made one important change in their approach—they decided not to share the gains on a measured basis. Instead they offered a flat annual payment. The union, after some hesitation, accepted the switch. The amount finally agreed upon was $5 million per year for 5½ years. This, together with the 1¼ million dollars already accumulated, would result in a total of $29 million. The agreement is to terminate in June 1966, at which time the parties will decide what to do next. It is extremely unlikely, however, that the agreement will be modified substantially. In all likelihood the freedom to manage will be extended again for an agreed annual payment.

The ILWU-PMA agreement is significant in several respects. First, it represents a specific accomplishment in resolving what otherwise would be a stalemate on the issue of restrictive work rules. Second, it implies the tacit admission by management of a man's right to his job—even to the restrictive work rules, which are part of it. Such rules have a value—and for giving them up, the man is compensated. And finally, the principle is accepted that labour is entitled to share in the gains that result from technological change. The fact that the share is stated in terms of a flat amount per year rather than as a portion of the value of the manhours saved does not alter this fact.

Much more could be said about the advantages and disadvantages of this type of solution. But, whatever these may be, the fact remains that despite the stormy labour history of this industry, the parties involved found it possible to work out a mutually acceptable solution. Management got the freedom it wanted—and the union got the security it wanted.

It is debatable how many other unions could work out a solution under which union members would not lose their jobs. In fact, even this longshore agreement, while it safeguards the rights of the class A longshoremen, completely ignores the fates of the class B and casual longshoremen. These workers are expendable, and no one takes up their cause. It is highly questionable, for example, whether such industries as steel, or railroads, or automobiles, or meat packing—to name only a few—could move ahead with unlimited technological change without throwing hundreds of thousands of workers out of jobs.

Pacific Coast Waterfront Mechanization and Modernization: The Collective Bargaining Approach

by W. L. HORVITZ, (Matson Navigation Company) and P. LANCASTER (Pacific Maritime Association).

This paper was, of course, complementary to that on Union Rules. The authors first gave specific details of the bargain described by Mr. Kossoris and then proceeded to explain its implications.

On October 18, 1960, Pacific Coast steamship, stevedoring and terminal companies, members of the Pacific Maritime Association (PMA), signed a five and one-half year contract with Harry Bridges' International Longshoremen's and Warehousemen's Union (ILWU). Under this agreement, the waterfront employers may change their cargo handling methods and introduce new equipment without fear of union interference. Even more important, the restrictive working rules, which long have been a part of the contract, have been drastically rewritten in the employers' favour.

These are the major revisions in the working rules:

1. **Changes in gang sizes.** Employers have the right to determine the proper manning for all new operations. For existing operations, manning may be reviewed in the interest of eliminating unnecessary men. Manning on which the parties cannot reach agreement is to be submitted to the industry's Coast Arbitrator for determination.
2. **Elimination of multiple handling of cargoes on the docks.**
3. **Changes in the sling load limits**—when an employer provides the necessary men and machinery in the hold of the ship to handle the increased volume of cargo.

The ILWU is pledged to co-operate fully in making these changes. In return the union receives a payment of $5,000,000 per year for the life of the contract. The $5,000,000 per year will be paid into joint employer-union trust funds and will be used to encourage early retirement, to make severance payments at retirement, and to provide a guarantee of earnings if changes under the programme reduce work opportunity below a certain level. Various insurance benefits are also provided.

The ILWU-PMA agreement has been hailed widely as a forward-looking answer to the problems of automation. This claim may be extreme, yet it understates the accomplishment. The changes in methods of cargo handling which are now taking place —and which have been taking place for ten years or more—are of great importance, but they are in no sense similar to the "automation" which is being talked about by other segments of American business and industry. There are few, if any, self-operating, self-guiding machines on the waterfront. The waterfront is in its first industrial revolution, while the rest of American industry is in its second industrial revolution. Both revolutions increase productivity, but bring about the elimination of jobs and the displacement of labour. For shippers and shipping interests, the modernization of methods on the Pacific Coast must be of real interest. For those not directly concerned with the handling of cargo, interest lies in the concepts and attitudes by which management and the union were able to find a common ground for their agreement.

A union survey of the same year shows how far mechanization had advanced during the preceding years, even without the co-operation of the union. In its report, the union cited the shift to bulk handling for various commodities not previously handled in that fashion, including wine, rice and paper pulp; the use of unit or shippers' packaged loads; the packaging of lumber; the use of cribs, cargo boxes and vans; and finally, the development

of containerization with the introduction of special ships and other equipment.

What was clear in 1957—a trend to mechanization—has become clearer since. Matson Navigation Company has continued to expand its container operations and has converted a ship entirely to the handling of automobiles. The first of American President Lines' two partially containerized ships is now sailing. These two ships have their own gantry cranes and are employed in the Trans-Pacific trade. Most of the lumber trade consists of packaged loads, and it can be said that this considerable segment of West Coast shipping has been wholly revolutionized. Alaska Steamship Company continues to expand its use of cargo boxes, vans and containers.

In the union survey which I have mentioned already, the ILWU recognised this trend and made two significant statements:

1. "The common feature of all these methods of operation is that they are labour-saving. They result in fewer manhours per ton of cargo moved. If this were not true, the employer would not make the change."

2. "We think it is obvious that some part of the development of vans, cribs, etc., has been the result of our refusal to modify our rules. Shippers were driven to drastic changes in order to circumvent our restrictions. It is quite possible, indeed, that the pace at which these devices have come in may have been greater than if we had worked out some compromise approaches."

The union noted that its policy up to that time could be described as "one of intermittent guerilla warfare directed against all changes we anticipate will reduce the need for men." And they emphasized that "the current decline in work opportunity (due to mechanization) will, if it continues and develops, make all the many issues involved much sharper."

Before commenting further on the significance of these statements, I would like to stress that, in the management's judgment, the union policies which derived from this report helped to serve the interests of the union and the longshore industry of which they are a part. The ILWU had the choice of bucking the trend or turning it to their own advantage. They chose the latter, and in so doing, allowed the West Coast steamship industry to change its operations and to modernize in a favourable climate.

Unfortunately, union-employer relations are often thought of in terms of combat, though it must be admitted that there may be reasons for this popular public conception. One of the rules of combat is to "size up your opponent." The statements I have quoted provide a unique opportunity for sizing up the ILWU. There have been many important shipping personalities who believed that the ILWU was seriously misguided; but there have been few who thought that the ILWU was woolley-headed.

It is the business of unions to anticipate the economic trends which will affect the jobs of their members, but it is something else again for a union to point out, and point out so clearly, that the trend to mechanization and the eventual concomitant loss of jobs may be directly due to the restrictive work practices which the union is, itself, fostering. It is not mere coincidence that the Mechanization Agreement of the West Coast deals for the most part with the correction of restrictive rules. If labour-saving devices are sooner or later going to make hash out of working rules which are designed to protect jobs, may not the cost of the device, and the expense of the struggle to impose working rules on that device, be spent in off-setting the loss or giving up of such working rules? Do not misunderstand me. The cargo handling industry needs **both** relief from burdensome working rules **and** mechanization. Mechanization to justify itself, must render a better service, pay for itself, and return a profit. If it can do this, and if the industry is freed of restrictive working rules, you have the best of all possible worlds.

But the important idea is this: Of what value to a union are working rules that keep unnecessary men on the job? Such rules are a source of trouble to the union and costly to maintain. By the inexorable processes of the American economy they are sooner or later doomed—for either the rules strangle the industry and it ceases to compete, or competition forces abandonment or relaxation of the restrictions. Of what value are the rules to the union? A union may ask, "Of what value to the employer?" If the union sells or sacrifices the rule, may not the resulting labour savings be enough to pay some sort of job protection to the union, or help to preserve related jobs from the forces of competition?

Salesmanship is one of the glories of the American system, but unfortunately, the three most common phrases in the language which refer to selling are: "Sold a Bill of Goods," "Sold Down the River," "Sold Out."

With respect to the agreement I have been discussing, management has been accused of selling out to the union. And the union has been accused of selling out to management. A union official I know got into an embarrassing situation when he described how the new contract had been explained to the rank and file workers. He inadvertently said that the workers had been **sold** on making the necessary changes. I put it to you that both management and the ILWU knew what they were **buying.** It isn't likely that the hard-headed unionists of the 1957 survey or the management of today's hard-pressed steamship industry were "sold" anything. The changes brought about by the agreement will, indeed, affect every worker and every job and will seriously disturb the traditional conservatism of the worker and the sacredness of status quo. To say that the contract needs explaining and selling is but to point to the far-reaching planning of the parties.

In 1957, as a result of the mechanization gains made in the years preceding, management and the ILWU started discussions of the problems attendant on the changes taking place. There was an exchange of documents stating the objectives of the discussions. The parties said, "We propose to attempt to develop a single overall plan or formula for dealing with operational changes . . . We believe that the terms 'mechanization,' 'automation,' and 'containerization' are misleading and too restrictive. We propose to discuss cargo handling operations as a whole —including introduction of new methods, expansion of present methods, removal or modification of existing restrictions which hamper output—with and without mechanization or additional investment in machinery, facilities and equipment."

In 1960, at the conclusion of five months of negotiations, at the fortieth meeting between the employers and the ILWU, Mr. Bridges reminded the parties of the 1957 exchange of documents, and remarked that the agreement which was about to be signed seemed to realize the objectives originally stated. I again quote the 1957 documents:

> "Objectives: To extend and broaden the scope of cargo traffic moving through West Coast Ports and to revitalize the lagging volume of existing types of cargoes by: encouraging employers to develop new methods of operation; accelerating existing processes of cargo handling, and reducing cargo handling costs in water transportation, including faster ship turn-around."

These objectives were to be accomplished without: individual speed-up, breaching of legitimate safety rules, indiscriminate layoffs, or driving away any existing cargoes. The benefits derived from such a programme were to be shared with the longshoremen, and the work force was to be preserved—a concept which was later modified to include the reduction of the work force by normal attrition and accelerated retirement until such time as work force and work load were in balance.

In the beginning, the discussions on modernization took place

outside of formal negotiations, but since the ideas involved were fundamental to the total contract, the influence of the talks was bound to be felt during bargaining. Companies continued to mechanize, and special manning agreements and working rules within the contract were devised to cover such circumstances, but the parties were still lacking a general solution and seemed to be making but slow progress.

Management, during these years, reduced the problem to two questions: If you agree to pay for drastic revisions to the contract, how can you be certain that the union will live up to its obligations and that you will harvest the crop you have put your seed money into? The second question was as crucial: **What were such changes worth?**

In answer to these questions, management reasoned: If a means could be found to measure the gains obtained under a revised contract, then payment could be made proportionate to manhour savings actually realized. No manhour savings, no payment. The employers sought means to accomplish this, beckoned by the prospect of the free right to mechanize their operations and a contract from which burdensome working rules had been eliminated. In 1959 the union, concerned over the acceleration of mechanization, said that the time had come to fish or cut bait. Management still enticed by the possibilities, still uncertain of its ground, asked for more time and offered a payment of "earnest money." It was a substantial sum: For one year of grace, one and one-half million dollars. But it also bought the right to mechanize without union interference during the ensuing year.

Meanwhile, during the same years, something else had been happening which was to radically change the employer philosophy and ultimately become the foundation of the bargain that was to be made. Domestic and foreign steamship interests having business on the West Coast had discovered that the common problem of ever-increasing labour costs was incentive for a new kind of management co-operation. (I am sure that most of you are aware that cargo handling costs account for from 50 to 60 per cent of total freight service costs.) The management of the various steamship companies, as a group, began an extensive examination of their cargo handling methods, the operations of the contracting stevedores with whom they did business, and, above all, the effectiveness of the existing contract. The dominant question was: "Are we getting all we can out of the present contract?" Attention was focused on those abuses which had drained the contract of its virtue. It was found that management had been both competitive and negligent and that the union had been ready to take advantage of either.

To correct this situation, Pacific Coast shipping interests, in 1958, instigated a conformance and performance programme dedicated to the proposition that one of the most effective of all labour-saving devices is the observance of the contract, under responsible supervision. This was no paper programme. It was run by a group of steamship company executives, operating men, who were willing to devote hours and days and nights of work and attention in order to make the programme work. The same Committee is directing this programme under the new contract. There are employer sub-committees assisting them in each of the major port areas on the West Coast. The gains in improved productivity have more than justified the efforts, and on the Pacific Coast, no one under-estimates the accomplishments of the programme. To prove they meant business in the matter of contract conformance and cost cutting, the steamship companies amended the By-Laws of the Pacific Maritime Association to provide for the assessing of fines on member companies who advertently or otherwise permitted contract abuses. The term "stepping up to the $5,000 window," referring to the assessing of fines, has become common slang in West Coast shipping circles.

The uniform membership also had to be convinced that the employers meant business when it came to enforcing the contract, and as a result, there were several work stoppages when rank and file workers resisted the tightening of work practices. But the employers made their point and it must be said that the union leadership did not actively oppose the programme for they had agreed to the principle that the employer was entitled to a fair day's work for a fair day's pay.

At the same time that the employers were salvaging the contract from abuse and were learning to enforce it properly, the agreement itself was being modified to provide greater flexibility in cargo handling operations. These changes were coincident to the overall prospect of a revised contract and improved operations, but, together with the conformance programme I have described, they pointed the way in unmistakable signs, to the possibilities ahead: In negotiations, the union asked for and got major changes in the hours of the work shift. In 1958, the traditional 9-hour shift was cut to 8 hours, and in 1959, a guarantee of 8 hours pay was given to gangs or men turned to. The employers agreed to these changes on the condition that there be greater flexibility in the employment of men so as to avoid any increase in the cost of cargo handling. This flexibility included the almost complete relaxation of gear priority; that is, the right of gangs to finish work in a particular hold when once turned-to in that hold. Flexibility also included the right to peel off gangs as work on a ship finished, and the right to move gangs from one ship to another or even from one company to another as work and need dictated. When these modifications of previously restrictive working rules were made operative, the employer committee supervising the conformance programme found themselves faced with a new rash of contract enforcement problems. This was a rehearsal in earnest of what would happen when major revisions were made in the contract. The lessons of the rehearsal were simple: In spite of the problems and the work required, such changes could be made to pay—and the pay made the effort worthwhile.

Persons familiar with Pacific Coast longshore negotiations during these years often ask, "What made management abandon the idea of payment proportional to the gains?" The pay-as-you-save plan was dropped because the steamship companies felt they had a better plan and because the prospective disadvantages of a pay-as-you-save plan had come to seem considerable. The steamship companies thought it was better to provide for the payment of a flat sum out of which would come agreed upon benefits, and this is the present contract. It is better because the companies are not committed to payments which might, in the future, outrun the purposes for which they are made. The employers see their purposes as (1) making the worker as whole as possible if he loses work under the changes proposed and (2) encouraging surplus workers to withdraw from the force so that there will be full work opportunity for those remaining.

The new plan leaves room for bargaining in the future. The price of modernization can be reviewed and the method of payment discussed, without the pay-as-you-save formula and its attendant mechanisms operating as a confining framework. This possibility—the bargaining away of future bargaining power—was of great concern to the employers. Similarly, they were concerned that they might set a pattern which could eventually lead to saddling the industry with a permanent royalty on each ton of cargo or each operation. It seemed pointless and dangerous to pay a tax or tithe which, like the United Mine Workers tax on coal, might be collected with little consideration of the worker's claim or need.

The measurement of waterfront operations is like trying to catch quick-silver in a sieve. The ship on berth today is gone tomorrow, and the near-primitive operation of the morning gives way to an engineering wonder in the afternoon. It is not Dr.

Kossoris's fault that PMA has not yet satisfied itself that it knows how to completely measure the manhour savings being harvested. Dr. Kossoris, at our request, took a year's leave of absence from the Bureau of Labour Statistics to devise and put into operation a system which the Association is still using to measure cargo handling. But the nature of cargo handling in itself and the cost of accurate and detailed time keeping seems to defeat any attempt to identify and measure the factors which cause improvement. Is today's gain due to a superintendent who got up on the right side of the bed this morning or due to change in the contract? And what should you pay the union for the savings made in each case.

In 1960, management could not convince itself that it knew enough to undertake a pay-as-you-save programme and be safe. And, as I have said above, management doubted whether it wanted such a programme. But time was running out, or more importantly, the time was ripe. The steamship companies were convinced by the tenor of the bargaining that 1960 was the year in which to revise the contract. It seemed likely that if the employers did not take advantage of the opportunity, the union would offer less or bargain from other premises in the future. With this incentive, management devised the present agreement in lieu of pay-as-you-save, and the union accepted it.

The idea of paying a flat sum was made possible by management's experience in 1958 and 1959, which as I have said, were years in which revising the contract was rehearsed. The value of an all out revision was forecast by the savings of those years, and from that forecast the amount to settle in flat sum payment could be gauged. The risk was the risk of any business investment—the payment was ventured upon the judgment of a responsible group of executives that the returns would justify such risk as was involved.

In the final analysis, the new contract stands upon a principle which began to take shape in 1957 when the ILWU saw that there must be an inevitable decline in the number of jobs if such jobs were without true work content and were maintained by enforcement of meaningless working rules. **Labour-savings** must, by definition, imply three things: (1) Savings; (2) Fewer Jobs; (3) A Reduced Work Force.

A work force may be counted upon to shrink by natural processes unless jobs without work content are artificially maintained and new workers brought in to fill them. The ILWU decided against this because it was contrary to the economic forces at work. The union was aided in making its decision by the fact that there were many occasional jobs in the industry worked by other than union longshoremen—teamsters, warehousemen, etc. A reduction in the amount of available work would eliminate these jobs first. And the union frankly looked to the dollar savings in labour savings to pave the way for the changes which were to occur. Obviously, as an answer to the problem of displaced workers, these principles have limited application. But just as obviously, this is a courageous attempt to come to grips with the problem: The union does not insist on maintaining the useless job empty of any real work content. The union recognizes that somewhere in the future there will be a new equilibrium between the work to be done and the number of workers to do it. As a representative of management, it is my opinion that this approach serves the interests of the union well. That it also happens to serve the interests of management is a fortunate coincidence but was not the objective of the union planning. However, I think the union is interested in helping the industry to health because a healthy industry can provide maximum employment.

Under the contract, union members will receive benefits as follows:

(1) On completing five years of service, $2,600 worth of life insurance. The amount of insurance increases with each additional year of service to a maximum of $5,000 at 20 years of service. At retirement the insurance is dropped and the vesting benefit becomes payable.

(2) Benefits, somewhat inaccurately called vesting benefits. These are payments at the rate of $220 per month to men who are age 62 or older and who have completed 25 or more years of service. To be entitled to such a payment a man must leave the work force. Payments run for three years. Men become eligible for the established pension payments when they reach age 65. Under certain conditions, the vesting payment can be made as a lump sum and it is then worth $7,920. These payments are a new breed of compensation—part severance payment, part dismissal wage, part retirement payment. The industry does not consider them to be pensions.

(3) Supplementary unemployment payments, although, again, the term is misleading. Unemployment refers only to loss of work opportunity due to contract changes. If work declines because the volume of cargo to be handled declines, payments are not due. The payment will be based on a 35 hour week or the figure of $100 per week which is roughly equivalent. Workers receive the difference between pay earned and $100. Because the coast has industry hiring halls and equalization of hours and work opportunity, no man can become eligible for a payment until the workers in the port area as a group become eligible. Men must have made themselves available for work in order to qualify for the benefit.

The times, the economy, and the position of American shipping versus foreign shipping have made labour savings the paramount force in the shipping economy. For management it was "do or die." For labour it was "do or resist to the death." Both sides had to recognize the problem before they could co-operate in solving it or in trying to solve it. Both sides had to co-operate if they were to achieve a solution or a partial solution. I have stressed that one of the foremost conditions in the undertaking of this programme by management was the co-operation **by** management **with** management in order to achieve the cost savings which they could realize as a group but not as individual companies. Of no less importance was the willingness of labour and management to understand and respect each other's point of view. Without such willingness to understand, there would be no modernization agreement today.

Neither of the official discussants on this paper, Dr. Emanuel Stein, Professor of Economics, New York University and Dr. Walter S. Eisenberg, Consultant Economist to the International Longshoremen's Association agreed that the PMA bargain was likely to be a long-term solution of the labour problems arising from mechanization in the Pacific Coast ports. The agreement would be satisfactory for the permanent waterfront workers, they thought, but retraining unemployed port workers presented a much bigger problem than was generally appreciated.

The Port of the Future

(Paper Presented by the U.S. National Committee of I.C.H.C.A.)

Containerization is, of course, a current topic of conversation and discussion in the United States where, in recent years, ingenious systems have been introduced, employing special vehicles, ships and equipment. It is upon this concept that the U.S. National Committee have built their "port of the future." Many delegates believed, however, that no such complete development could be foreseen and that, for practical purposes, it was necessary to plan on the assumption that, for a very long time into the future, general cargo vessels will be called upon to carry piece, palletised and bulk commodities, as well as cargo in containers.

However, the paper, which was obviously the result of much thought and effort, was received with interest.

After a historical review of the development of the world's transport and communication systems, the authors continue:

"The impact of the era we are now entering in world transportation on the Port of the Future might be characterized by some as the era of the portless port. To clarify our meaning, it is perhaps necessary to mention, but not to dwell upon, some basic questions of the cargo transportation industry. The primary function of the ports, as components of cargo transportation systems, is the transfer of cargo between ocean and inland carriers. As an isolated operation, transfer does not contribute to the movement of cargo and, once it can be separated from the hustle and bustle of auxiliary port activities traditionally associated with manual handling of goods on docks, the transfer of cargo will merely represent another link in the "system," differing from the ship and the inland carriers in only two aspects: (a) that it is stationary, and, therefore, (b) that its efficiency is measured in cost per ton/day, rather than cost per ton/mile.

The reality of such separation of transfer activity from auxiliary port activities may be difficult to visualize, but its feasibility in the light of modern communication methods is unquestionable. Sorting, storing, inspection, marketing, packaging, and all general administrative services associated with present-day cargo terminals need no longer take place in the vicinity of the vessel berth—any more than airline ticketing or traffic control need to be handled at an airfield hangar.

If the feasibility of such developments is conceded, their realization will still require economic motivation. And such motivation will originate with competitive economic pressures to reduce all transportation costs, particularly the need to minimize the cost per ton while cargo "stands still" during its transfer between ocean and inland carrier.

The question then arises: Where, if not at the port, do the auxiliary port activities take place? And a reasonable answer to this question would be: In the areas or regions to which most of the cargo is consigned, and where most of the cargo originates. If a port region is also a large consumer or producer of goods, it would be logical for this region to contain large cargo distribution centres; these centres may or may not be in the vicinity of vessel berths, depending on the physical limitations of port terminals, the availability and efficiency of local means of distribution, and on incidental pressures created by locations and space requirements of surrounding residential, industrial, and recreational developments. If a port region is not a large consumer or producer of goods, cargo distribution centres can be located elsewhere, and facilities at such a port can be limited to the most efficient transfer installation, comprising only such storage space as is necessary to accommodate the " surge effect " of cargo between vessel sailings, and only those administrative and auxiliary functions that are directly required for the transfer operations.

Hence, in describing the Port of the Future as a part of the **total** transportation system, it is intended to direct attention to the technology of cargo transfer, and to approach the development of future ports with the concept of their basic function.

Cargo Transfer Technology

The realization of the new port era depends, of course, on the degree of implementation of the containerization/unit load concept of cargo handling in ocean transportation. In the domestic ocean trades, the concept of containerization has undoubtedly been proven. In the foreign trades, however, containerization is not yet fully accepted and is far from being established.

The inevitability of this taking place eventually, however, is perhaps best illustrated by a theoretical, but sound, analysis of the economics of the containerization method of cargo handling as opposed to the conventional breakbulk system. It should be noted that this analysis applies only to ship operation—whereas equally significant savings are produced in other phases of the transportation cycle under the integrated form of transportation.

Table A below, shows the dramatic difference in cost between the conventional and container-ship operation. Transposing the figures in this table to a comparative analysis of total fleet operations under the same conditions (Table B), we see quite plainly the benefits, and therefore the inevitability, of this method of cargo handling.

TABLE A

Annual Cargo Handling Cost per Fleet (add $1,000)

Cargo carried per year:
Revenue tons 1,080,000
Long tons 675,000

Ship type	Conventional		Containerized		
Container cargo, % direct ...	0	0	20	50	100
Container cargo, % stowed at pier	0	100	80	50	0
Annual cargo handling costs:	13,200	1,400	1,400	1,400	1,400
Stevedoring	0	4,300	3,450	2,150	0
Load-Unload Containers	0	80	80	80	80
Claims	430	0	0	0	0
Total Annual Cargo Handling Costs	13,630	5,780	4,930	3,630	1,480

TABLE B

Comparison of Economics of Fleet 8,000 MI. Route; 675,000 Long Tons Cargo Per Year

Ship speeds, Knots	20		20		
Ship type	Conventional		Containerized		
Container cargo, % direct ...	0	0	20	50	100
Container cargo, % stowed at pier	0	100	80	50	0
Annual Costs (add $1,000)					
Capital	2,320	2,920	2,920	2,920	2,920
Operating	3,660	2,730	2,730	2,730	2,730
Cargo Handling ...	13,630	5,780	4,930	3,630	1,480
Terminal allocation ...	1,000	1,000	1,000	1,000	1,000
Overhead and allocations	1,500	1,500	1,500	1,500	1,500
Total transportation cost	22,110	13,930	13,080	11,780	9,630
Cost dollars/long ton ...	32.8	20.7	19.4	17.5	14.3
Evaluation					
Assumed revenue, $1,000	23,610	23,610	23,610	23,610	23,610
Profit, $1,000	1,500	9,680	10,530	11,830	13,980
Total investment, $1,000	32,750	30,200	30,200	30,200	30,200
Return on investment, %	4.6	32.0	34.9	39.2	46.0

Noncontainerizable Cargo

The adoption by a ship operating company of a fully containerized system carries with it certain implications in regard to cargo that cannot or should not be containerized. As we see it, this problem will probably be dealt with by the elimination of such cargo from the manifests of the containerized ships or the development of ships with dual purpose capability of carrying both types of cargo. The cargo handling equipment will handle breakbulk cargo at a rate such that the total time required is within that for handling the containers only. Certain cargoes will be handled in bulk or by specialized ships at special berths in the port. Such berths will be equipped with the necessary mechanical handling equipment to deal with the noncontainerizable cargo in the most economical and expeditious manner possible.

....

After outlining how the auxiliary port services would be organized to reduce the number of handling stages and to remove them from the vicinity of the ship's berth, the authors state, in conclu-

sion, that, in describing the historical development of shipping and ports over the last five centuries in the introduction of this paper, it was their intention to convey the continuum theory of growth. "That is to say, no one point of time can be picked when one could say a particular period had fully arrived or vanished. Rather, the history of ports, as indeed all history, merges imperceptibly from one period into another, and it is only the overall cumulative effect of a span of years that characterizes a period as one thing or another. Thus, we are quite well aware what constitutes the modern port of today and the facilities that make up such a port. The same port, however, contains remnants of the past as well as harbingers of the future.

Thus, the Port of the Future is already with us in many respects but when it will attain a cumulative effect sufficient to permit any particular characterization depends on too many variables and intangibles to make a prediction with any precision. Undoubtedly, however, we shall feel the influence of this concept in all port planning for the future."

The final technical session of the conference was held in the United Nations building and Signor Roberto Hertamatte, United Nations Commissioner for Technical Assistance, took the chair. In a short opening address he stated that his organization had been pleased to accept assistance in the past from members or member bodies of I.C.H.C.A. and added that, if expert knowledge were again required on any subject in this field, there would be no hesitation in calling upon the Association to give it.

To conclude the business of the conference, the new President, Rear Admiral McLintock gave a summary of the proceedings, ending by saying that he firmly believed that the world transport industry, by its support of the meeting, had recognised the need for achieving efficient, economic and improved handling systems in commerce and was prepared and anxious to take the necessary steps to bring this about.

The executive committee of the Association now consists of M. G. Sirtaine (Chairman) (Belgium); Mr. I. S. Lloyd (Vice-Chairman and Honorary Treasurer) (U.K.); Dr. Luigi Accame (Italy); M. R. Courau (France); Mr. R. P. Holubowicz (U.S.A.).; Dr. Ernst Sutor (Germany). Mr. Lloyd was a guest speaker at one of the two official luncheons during the conference and held his audience with a stimulating address upon the developments in ship operating and cargo handling in Great Britain, referring particularly to advancements made in the use of containers. The guest speaker at the other luncheon was the Hon. D. B. Lowe, Commissioner of the Port of New York Authority, who discussed the contribution which the transport industry as a whole could make to world peace.

The conference was a successful one. The papers were well presented and the listed discussants made useful contributions. As already stated, however, it seemed a pity that a period of time was not allowed towards the end of each session for contributions to be made from the body of the hall.

Timber Engineering Conference

First International Meeting at Southampton

by J. P. M. PANNELL, M.B.E., M.I.C.E., M.I.Mech.E.

The growing interest in timber as a structual material has led, almost inevitably, to a need by workers in timber engineering to compare notes. This has led to the holding, at Southampton University, of a five day international conference on the subject.

Arranged jointly by the Department of Civil Engineering of the University of Southampton and the Timber Development Association, the conference attracted 147 delegates from 18 countries, which, besides the United Kingdom, were Australia, Belgium, Canada, Czechoslovakia, Denmark, Eire, Finland, France, Germany, Ghana, Holland, India, New Zealand, Norway, Sweden, Turkey and the U.S.A. It is regrettable that delegates from the U.S.S.R. and Poland were, at the last, unable to attend. Those attending represented a wide range of interests, including engineers; architects; research workers in government establishment, universities and independent laboratories, mass producers of timber structures, contractors building one at a time, and members of the hardwood and softwood timber trade.

Of the 20 papers presented, about half dealt with problems of timber roof construction, this being broadly the theme of the conference. Whether specifically referring to roofs or not, most of the papers raised questions of interest to all engineers using timber as a structural material and the lively discussions at all the sessions proved that the authors and subjects had been well chosen.

The conference was opened by Professor P. B. Morice, Dean of the Engineering Faculty of the University of Southampton, who had been the leading spirit in the initiation of the conference.

The conference, at its first session, discussed four papers "The prejudice against structural timber" by R. J. M. Sutherland; "Laminated roof structures in Canada" by R. F. De Grace; "A review of problems and solutions of timber roofs in India, through research, design, and demonstrations" by N. J. Masani and others; and "Problems of Standardisation in design of timber roof construction" by Z. Golebiowski.

Mr. Sutherland made full use of the somewhat provocative subject of his paper, which attracted most of the discussion at the session. In assuming that there is a prejudice against timber for structures, the author had, intentionally or otherwise, ignored the continued use of timber by dock and harbour engineers, river and canal engineers, and railway engineers, All these have used timber whenever its use has been appropriate and suitable supplies have been available. In fact, if it is possible to generalise, engineers who have to live with their works have continued to use timber extensively; whereas those whose interest, following the completion of their works, becomes purely academic, have tended to regard timber as suitable for temporary use only. This view reflects the attitude of the client, and Sutherland, from the position of the consultant, puts the matter in the following words.

"The prospective building owner thinks of timber as a temporary combustible material; at the best he may see images of fancy cricket pavilions, at the worst of shabby hutting.

The architect on his side frequently strives after woody finishes which sometimes he hopes to marry to the structure. This can be very successful but it is significant that it is nearly always done on a small scale and that when he has a large job the architect turns to steel or concrete.

"The engineer, especially the younger one, looks on timber as beneath him—steelwork is all right, reinforced concrete is proper engineering and pre-stressed concrete is positively holy, but timber, no, this is the stuff for joiners.

"The general contractor thinks of timber in terms of traditional joinery and carpentry, carried out by craftsmen who are in short supply and have to be treated with some respect".

His recommendations to improve this position refer in the main to the use of softwoods and, even if they are not entirely effective in removing all existing prejudice against timber, cannot fail to help the efforts of those who already accept wood

as a material of construction worthy of consideration in competition with steel and concrete. Sutherland divides the problem into parts, each representing the contribution which may be made by 1) the timber merchant; 2) the manufacturer; 3) the designer; and 4) the research worker.

From the timber trade he pleads for better attention to stress grading, and asks for a greater number of grades. He also, quite fairly, asks the merchants to provide more information on prices and availability of the grades and this to be reviewed at frequent intervals. Hardwoods, he suggests, can with advantage, be introduced into the Code of Practice in appropriate groups.

From the manufacturer, the main contribution would be a change from the old craft approach to one combining craftsmanship with technology, so that the consumer may expect a finished product in more accordance with his specification than he often gets today when the craftsman interprets his design to conform with traditional practice. Another suggestion for the manufacturer is for the provision of standard built-up sections; mostly rectangular, and composed of say three or more laminates with staggered scarf joints. Timber of varying lengths could be incorporated without waste and members of 40 feet length and more provided as a matter of course. The system would at first be expensive, but the many advantages, including the possible provision of books of safe load tables and section properties, could possibly justify the extra cost involved.

Sutherland alleges that engineers are less capable of designing in timber than in steel or concrete. This may be true in consultants offices, but does not apply to the offices of dock and harbour engineers or their colleagues in similar branches of the profession. Neither can it be said to apply to engineers in contracting, who are able to make full and economical use of timber in temporary works with a skill which could equally well be applied to structures of a more permanent nature.

In his comments on research, Sutherland praises the work of the Timber Development Association, a commendation which few, if any, will dispute. He appeals for more trade support for the association's research programme and especially for an immediate expansion of university research into timber engineering.

The last part of this paper deals with possible future developments, of which the most acceptable to the practicing engineer would probably be the suggestions which the author makes for composite constructions, especially those in the form of composite two and three dimensional triangular beams.

In the lively discussion on the first group of papers, most speakers dealt with points made by Mr. Sutherland. Mr. J. G. Sunby of the Forest Products Research Laboratory, pointed out that even if the trade had often been blameworthy, many architects and engineers had been guilty of specifying the impossible. He felt that the term "stress grading" had a frightening effect on the supplier. Referring to seasoning, Mr. Sunby pointed out that most imported timber required extra sorting and seasoning before it was fit to be used in timber engineering work.

Dr. L. G. Booth, Consulting Engineer and Research Fellow of the University of Southampton, complained of the paucity of information on timber structures and particularly on the use of adhesives.

The merchant's case was put by Mr. G. B. Crow, who said that while it might be convenient for engineers to have stress graded timber available from stock, the keeping of such stocks was an expense which merchants could not afford to meet and that the main responsibility for stress grading should fall on the users or their contractors. He suggested that the Timber Development Association might run short courses in the subject for the instruction of clerks of works and timber inspectors.

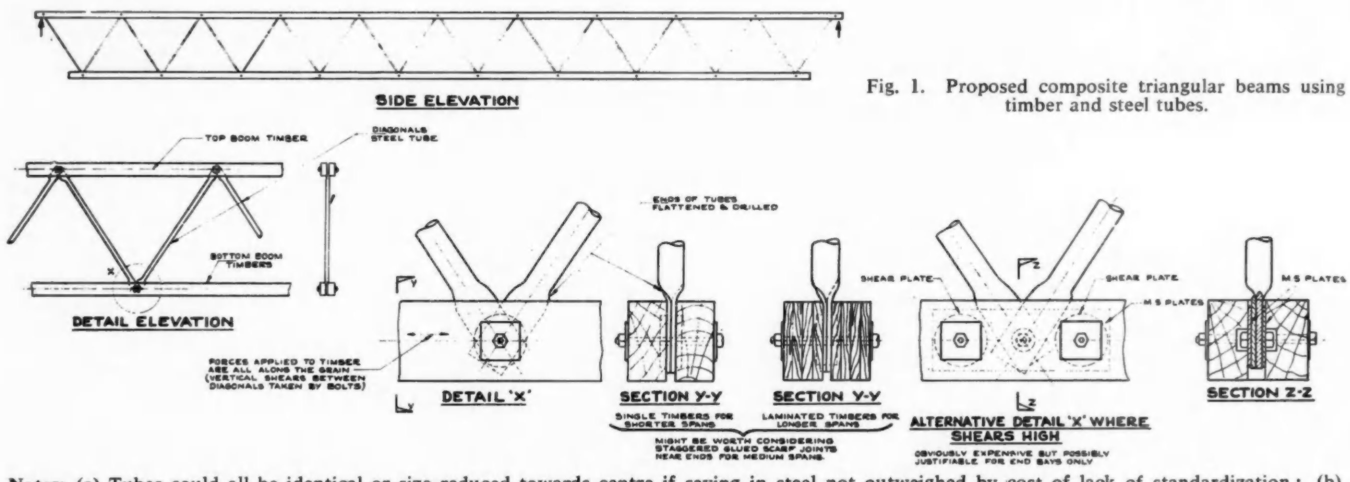


Fig. 1. Proposed composite triangular beams using timber and steel tubes.

Notes: (a) Tubes could all be identical or size reduced towards centre if saving in steel not outweighed by cost of lack of standardization; (b) Tubes could be supplied with flattened drilled ends and either painted, galvanised or stove enamelled; (c) Beams could be assembled on site or in factory; (d) Limitation on load and span is normally given by shear strength of 2 No. Shear Plates (2½-in. or 4-in.) with Group I timber. Alternative detail 'X' shows a way of overcoming this limitation, although at the expense of simplicity; (e) Bull-dog connectors can be used instead of shear plates or bolts alone where shear forces are low; (f) The main advantages of this type of beam are the neat appearance, flush sides, top and soffit (no projecting diagonals) and narrow width. They can readily be boxed in if required.

A valuable paper on "Laminated roof structures in Canada" by R. F. De Grace, Executive Director of the Canadian Wood Development Council, gave a far wider review of Canadian practice in timber engineering than the title implies.

De Grace referred to the wide variation in Canada of physical environment, which affected the engineer's approach to the subject, but throughout this range of conditions, laminated wood had proved satisfactory. Solid shapes of rectangular cross-section had proved to be the most practical, but for high grade work, quality control under factory conditions was most desirable, if not essential. He appealed for international co-ordination of plans for applied research.

Later session brought discussions on groups of papers with subjects in the field of Joints; Shells; Special types of Structure; Tests and Failures; Economics and Comparisons.

The last of these groups included a paper by Professor P. B. Morice and Mr. B. M. Annette entitled "Structural design with electronic computers" which described the production of elec-

tronic computation designed to relate the cost of buildings with their structural shape. This paper suggests further possibilities in programming for the dock engineer, such as the relationship between cubic spaces, the storage of goods, handling problems, column spacing, first cost, etc. While the solution of such problems will always be dependent to a great degree on experience and judgment, the electronic computer will surely provide even the most experienced dock executive with the means of reducing data to a more assimilable form.

The discussions were finally reviewed by Mr. Phillip Reece, late Director of the Timber Development Association, who referred to the more advanced state of timber engineering in the United States where the bow-string girder and laminated arch had been thoroughly assimilated. His fear was that, in passing over some of the intermediate stages of evolution in timber engineering, passing on to shells and folded plates, we might be going from "barbarism to decadence without the intervening stages of civilisation".

The last two days of the conference—Thursday and Friday—were spent in visiting works of interest in the South of England, these included not only a variety of new structures, but also three interesting roofs in Southampton of the 14th, 17th and 19th centuries.

At the conference dinner which was held on Thursday evening, suggestions were made for later conferences, to be held in countries of interest to timber engineers, and with particular stress of the possibility of a conference in a timber producing country, such as Canada or one of the Scandinavian group.

Exhibits on view at the University enabled members of the conference to view examples of the latest practice in timber engineering technology by displays of models, photographs and prototypes. These, together with the usual opportunities which occur on all such occasions gave the residents and visitors the subject matter and incentive for personal discussions which, no doubt, initiated contacts which will be of value when the participants return to their own countries.

While a great number of people were responsible for the organisation of the Conference, particular mention should be made of the efforts of the local secretary, Dr. H. G. Allen of Southampton University, who confessed that this was not only the first conference he had organised but was, in fact, the first he had ever attended.

Why Not Abolish Tallying?

Summing up by "POSEIDON".

The article "Why not abolish tallying," which appeared in the May 1961 issue of this journal, asserted that the remedy for the major stoppages that in recent years have afflicted the ports of the United Kingdom lay in the industry's own hands—to abolish import tallying. The re-action from readers has once more proved that before one can rouse port users it is necessary to be deliberately provocative. Not all the letters received however, were condemnatory. Some started in this vein but, being written by reasonable and practical men, ended by conceding many of the points that had been urged in favour of abolition. Taken together, the correspondence showed that from so generally accepted a dock practice as tallying, some good may come once its patrons can be persuaded to ask "Why is it done?"

The first welcome feature was the willingness to impugn the correctness of the present method of tallying. When results bear little resemblance to the quantity of cargo carried it is not surprising that in one major port some tallying has been discontinued. Bad marking, a multiplicity of marks, a general run of small bills of lading, all militate against correct results emerging from a practice the monotony of which is notorious, the conditions for its performance inhospitable and the perpetration of one error will negate the value of a day's work. No practical man will deny that this is an understatement of the case; neither will he question the loyalty of the tally clerk to his employer of the day.

That none of these things make for accuracy—the one reason for taking a tally—can be proved by the simple experiment of comparing the cards of tally clerks who, for different employers, have taken a joint tally. Perhaps those who doubt this will accept, in lieu, the recorded statement that nine separate tallies were taken of one parcel and they were all different.

The point is excellently made by one correspondent who is certain that cargo loaded 100% correctly—conditions for checking at loading are admittedly more leisurely than during the bustle of discharge—should not require to be tallied ashore. It is difficult to refute the principle that a higher standard at loading would save the ship trouble and expense later on.

Encouraging it is to note that at one port tallying has been dropped—with the dire result, according to the correspondent—that a claim amounting to £5 had to be paid. It appears that this satisfactory result was brought about because the courage of the port operator was matched by the efficiency of the port police. But are not all port police efficient today?

The importance of securing a record for piecework purposes is appreciated. Is not the laborious process of tallying, with its liability to spark off a strike that, in 1960, cost one major port alone, £600,000, not an expensive way of solving an administrative difficulty? So many port practices survive from the days when labour, both manual and clerical, was the cheapest commodity in the port. Do tallies for piecework purposes always have to be taken at the source, that is, at the point where the goods are being handled?

The inveterate abolitionist, as well as the unquestioning supporter, of tallying, will admit that there is variety in the means by which tallies are taken. They would, further, be agreed that therefore, some tallies are worth more than others. A layman would surely place more reliance on the detailed check made as cargo is handtrucked from the shed to the railway wagon than he would accord to the count taken of pieces of timber in a swinging set on its hazardous way from the hold to the barge. Therefore, says one reader, tallying should be done only where it can be done properly. The conditions of each type of tallying—and there are too many to list here—justify a careful examination. If there is a probability of error arising, or if it is reasonably certain that error cannot be excluded, then it should be seriously considered whether the process is worth the expense. Many will subscribe to the dictum that a bad tally does more harm than no tally at all.

An examination of the problem, of where tallies are taken, has brought to light that successive tallies are in fact taken at absurdly close intervals. Cargo, such as fruit or meat, is often in public demand; the dock shed is used merely for a minimum sorting before the cargo is hustled into the waiting lorries or railway wagons. Surely a landing tally taken a few hours, or even minutes, before a delivery tally of the same goods, can hardly contribute to the correctness of the ship's outturn. Similarly, goods received for export are scrupulously checked into the dock shed before being stowed to port marks, to await the loading stevedore's call for them. It may be a few days before the port authority is asked to tender cargo to the load-

ing gang. On its way out, at the shed door on the quay, the ship's checker will carefully check cargo that, at the shed door on the rear loading bank, has been equally carefully checked by the port authority's clerk. On the last loading days when the ship is hungry for cargo, exports may literally pass through the shed without being placed on the floor. The same goods are handed from the first clerk to the second who repeats the process before the ink on his opposite number's card is dry. Whilst the writer of these notes is not now in daily touch with the system of recording export discrepancies he can say that of the many thousand items of export cargo he has known to be listed as "in dispute", only one package was established over the years as not reaching its destination.

When a shipping company, for its own convenience, employs craft to supplement its landing gangs, why is an overside tally, with all its known hazards, taken? Surely the count taken ex barge on to the quay should suffice. What is the point of tallying cargo landed on passing-over-quay conditions?

There remains, after reading some of the correspondence, an uneasy suspicion that tallying is being done when no tallying is called for. The writer would hazard the statement that certain cargo is handled in conditions that do not include the careful scrutiny to which cargo on normal rates is entitled. To encourage certain traffic, port authorities and shipping companies have quoted rates for cargo which is "unprotected" or which they are prepared to handle on wharfage conditions. In the first case the external state of the goods is not the liability of those through whose hands they pass; in the second, both condition and quantity are a matter of indifference to the wharf owner. The writer some years ago discharged a parcel of bullion to a locked van supplied by the Bank of England. The quay was littered with police and there were the usual jokes about "sweepings" and "loose collected". Having selected the most reliable tally clerk on his staff he was blandly informed by a more experienced officer that no tally was ever taken on cargo landed on wharfage conditions.

Is it not a case of carrying the admirable dock caution rather too far, when one records scratches and blemishes on unprotected motor cars shipped on a cheap rate? Would claims be paid on earthenware or pottery broken when shipped as "unprotected cargo"?

Throughout the correspondence there is a King Charles head that will not be suppressed—the division of responsibility. It is possible to imagine a ship loading a full cargo at a berth that belongs to the shipper of the cargo; he is also the owner of the ship and the sole employer of the port labour. To carry the exercise further, suppose that he is also the owner of the discharging wharf, that he takes delivery through his shed of all the cargo and again, is the sole employer of the port and transport labour. In this happy state of affairs, were he foolish enough to tally at any stage of the process, he would merely be tallying against himself.

In so far as conditions today diverge from the above ideal, as the responsibility has been divided between port authority, master stevedore, shipping company and, in some ports, even the receivers, so has the need for multiple tallying come to be accepted.

Terminal services generally will need a drastic overhaul before tallying—that old man of the sea—can be removed from the ports of the world.

It would, however, be a great mistake to accept the worm's-eye view of tallying. Not all ports are handicapped by centuries of experience. Developments since 1945 are producing among the emergent nations, new ports, new and fresh minds among the proprietors of existing ports and a welcome reluctance to base their practices on what they rightly regard as the outmoded creeds of tradition and convention.

There is the feeling that if they could start without tallying they might remain free of the encumbrance that they read has, as late as August of this year, caused a two-day stoppage in the port of Manchester.

A true picture of the tallying problem can be had only by examining the position as it exists in world ports. From reports available it is evident that less regard is now being paid to tallies taken under overside conditions. Greater reliance is being placed on tallies taken when cargo is landed into shed, delivered from shed or admitted into warehouse. Efforts are being made to replace, where it is possible the overside tally, by one taken under more favourable conditions. Again, much progress has been made in many overseas ports in the mechanical handling of cargo. Palletised and in unit loads, time and money is saved in the terminal operations. In these ports the tyranny of the tally clerk has not been accepted. In another port a compromise has been reached to take quantitative tallies, or even merely to record the number of sling loads.

In conclusion mention must be made of a system which can be quoted as falling within the general pattern of cargo handling —that is the deferred acceptance of the obvious. The container was a commonplace in the port of London half a century ago; the forklift truck made its appearance shortly after the first war; the mobile crane appeared in a crude form even earlier. For the reason that the industry is not prone to jump at new toys there has, in each case, been a long delay, before the new plant has suddenly burst into full flower.

So it it with "In-stack" tallying. As its name implies it substitutes the uncertain count taken on the hook by the accurate examination of the flush front of a neat pile of cargo, sorted to marks either in the shed or in the stacking yard. Many years ago it was the practice to tally hardwood lumber after it had been piled to marks on the quay. Only after this was done was it admitted that liability could be accepted.

The Landing and Shipping Company of East Africa Ltd. have now overcome the reluctance of shipping companies using East African ports. They have installed the "In-stack" system; it is reported to be working satisfactorily. That this is so is confirmed by the information that they have at the request of the interests using South African ports, explained to them the advantages of the system. According to a report that recently appeared, an experiment is now being made in Durban and other ports. It is confidently predicted that South African shipping interests will also recognise that there is more value in having a reliable receipt within a few hours of landing than an admittedly unreliable one at the time of discharge.

This is not the place to set out the "In-stack" system in detail nor to illustrate it with the specimen documents that form the administrative accompaniment. It is sufficient to say that, by preliminary work done before the vessel's arrival, shed or stack yard space is allocated for landed cargo. To these places it is brought by mechanical means thereby giving the port authority the full benefits of a forward-looking policy. On arrival the cargo is stowed so that it can be counted in situ. Arrangements are made for the segregation of damaged cargo. The compilation of the vessel's outturn proceeds apace as in-stack tally cards are received, without intermission, by the administrative staff. The advantages are obvious. There is no interference with the discharge; fewer clerks are needed and those employed work without interruption; the programme of mechanisation can proceed without regard to tallying. In the unlikely event of industrial trouble with the tally staff the discharge of the ship is not affected.

If and when the shipping companies concerned finally accept that the in-stack system, as practised in African ports, is superior to that to which they have for decades been shackled in United Kingdom and Continental ports, what further proof will be required that tallying, in its present form, should be abolished?

Wave Recording for Civil Engineers

Proceedings of a Conference held at the National Institute of Oceanography

In last month's issue of the Journal we published the first of four papers which were presented in January to a conference on wave recording organised jointly by the National Institute of Oceanography and the Hydraulics Research Station. This paper was given by Mr. R. C. H. Russell and discussed the wave recording requirements of the civil engineer. We now publish two further papers, one dealing with methods of finding the directions of approach of sea waves and the other describing methods of recording sea waves and listing the instruments which have been used. The text of the final paper, describing a simple method of measurement of sea waves will be printed in November, together with excerpts from the discussion.

A Brief Survey of Methods for Finding the Directions of Sea Waves

by D. E. CARTWRIGHT, B.A., B.Sc. (National Institute of Oceanography).

Although the directions of sea waves certainly can be measured, there is no really simple method. The recording apparatus need not be complicated, but in order to obtain meaningful answers from the records a certain amount of detailed analysis or complex analysing equipment is unavoidable. It is a new subject with as yet rather few practical demonstrations, but there are engineering projects for which a knowledge of wave direction is very important, and doubtless the measuring technique will eventually become standard practice. It is certainly being studied by naval architects in application to the behaviour of ships in sea waves.

As with the more familiar problem of measuring heights and periods, the methods one adopts for estimating wave directions can be divided into two types: those for which one has time to record and analyse the waves **in situ** over a representative period, and those which, due to urgency, must rely on estimates of wave conditions over past years by means of weather charts. This survey will be mainly devoted to the first type of method, which in the present state of knowledge is perhaps the more reliable, but the following points must be borne in mind when using the second.

Hindcasting Wave Directions

Relationships for forecasting or hindcasting wave heights and periods from the winds which generate them have been worked out over the past 15 years or so, and are fairly well known. To calculate the direction as well one needs to take into account the bearing and distance of the generating area from the site in which one is interested, and also the distribution of directions produced within the generating area. For this one must have recourse to recent research material which is not widely known, but the important fact is that a wind generates waves in other directions besides that in which it is blowing. Actually in the earlier stages of generation there is a preference for other directions, which can be up to 90° from the wind direction.

The contours of the offshore sea bed must also be known, in order to account for the refracting effect of shoaling water. Here it should be observed that the same mechanism which causes refraction also causes magnification of wave height, so the study of height and direction are to some extent complementary. Certain shapes of bottom topography may shelter a coast from some directions of wave approach; other shapes may have a focussing effect, causing waves to converge on a point with consequent high local magnification. Waves can also change direction when running across a tidal stream, and this should also be taken into account.

All one needs basically then for a retrospective picture of wave directions at a chosen spot is a set of daily weather maps covering the seas to which the place is exposed, a refraction diagram calculated from bottom contours, some tidal stream data, and a certain amount of tedious computations. If work of this sort is carried out thoroughly the results will show that there are very few occasions when waves approach a place from one direction only. Sometimes there are crossing swells from two distinct sources; more often waves are present in a continuous range of directions of considerable angular spread, as when the wind is blowing over the local area. This is also evident from the appearance of the waves themselves. Waves travelling in a unique direction have crests which are many times longer than their wavelength, but crossing swells or a continuous spread in direction break up the crests into short elongated humps which make up the more usual appearance of the sea surface. The aerial photograph in Fig. 1 is of a typical wind-generated sea.

Recording Wave Directions In Situ

It is this "short-crestedness", as it is often called, which makes the direct recording of wave direction difficult. If the waves were long-crested there would be several very simple methods of obtaining their unique direction. With short-crested waves one can still obtain a "mean direction" by fairly simple methods, which may be accurate enough for some purposes, but to obtain more than this (not to mention the complete directional spectrum) one requires more complex equipment and techniques of analysis.

Spatial Surveys

There are three basic methods. The first is to survey a large area of sea surface, perhaps for a very short time, as in a photograph. The second is to record wave height at only a small number of fixed points, but continuously for some tens of minutes. The third method is to record not only height but also slopes or other quantities dependent on wave motion at just one place for several minutes. An example of the first method which springs to mind is an aerial photograph, but a glance at Figure 1 will show that there are difficulties in interpretation. One can gauge a rough alignment of the crests and deduce that the waves are progressing at right angles to this alignment, but whether "forward" or "backward" one cannot say without further information. Also the appearance depends on the direction (and presence) of the sun, and certain wave directions may not show up well; because of this a low but important swell underlying a choppy sea may be obscured.

Some measurements have been made by Cox and Munk in America using the glitter pattern of the sun's reflection in the sea surface. This approach is unlikely to be of use to engineers since the results are mostly due to ripples and very short wave lengths.

The most reliable way of interpreting wave photographs is by stereophotogrammetry, but it is important to have a wide coverage to the extent of several wavelengths. Some measurements made in America with stereo cameras in two aircraft 2,000-ft. apart and 3,000-ft. high have

produced the most complete analysis of wave direction yet made. But this was a large undertaking which could hardly be adapted for everyday use. If the photographs were taken from shore it would be essential to mount the cameras very high up, on a cliff or tower, for example. This of course applies to ordinary photographs also.

Another method of measuring wave surface profiles on which some research has been done at the N.I.O., is by means of an accurate radar-altimeter borne by an aircraft flying on a number of courses low over the sea. However, certain instrumental difficulties have not yet been overcome.

The only other known method employing a survey of a wide area has been suggested by N. F. Barber of New Zealand. It uses the principle that if radio waves are transmitted nearly horizontally in a narrow beam, they are reflected from those sea waves of exactly half their wavelength which are normal to the beam. Since the sea waves are moving, the reflected waves have a slight Doppler shift in frequency, which produces beats with the transmitted waves whose amplitude can be measured. (This effect has been shown to spoil B.B.C. television transmission in some coastal areas). By rotating the beam in azimuth we get a measure of the wave energy at a particular wave length travelling in each direction. We can then scan other wavelengths by altering the frequency of transmission. Barber suggests transmitting from a long wire trailed behind an aircraft, but for fairly short waves shore-based rotatable antennae should be possible.

Arrays of Height Recorders

Measuring direction by means of a small number of conventional wave-height recorders in an array avoids many of the practical difficulties of the above methods. The basic principle, illustrated in Figure 2, is quite simple. If two recorders are placed at A and B, distance d apart, then a long wave-crest advancing at an angle ϕ to the line AB passes B a small time τ after it has passed A. If T is the period and L the wavelength (deduced from T), then clearly

$$\frac{\tau}{T} = \frac{d \cos \phi}{L}$$

from which $\cos \phi$ can be deduced. d should be of the order of half a wavelength. Notice, however, that one cannot tell the difference between $+\phi$ and $-\phi$; in other words one gets the same result from a wave proceeding in a direction $\bar{\phi}$ from the other side of the line AB. But this is not usually important when AB is parallel to a shore line. In practice of course the phase lag τ varies from wave to wave just as the "period" does. A rough compromise may be made by taking averages, but the ideal and accurate method is to measure the phase lags by cross-spectral analysis, that is by filtering out all wave components except those with periods close to T. One method is to measure the spectrum of the two records individually and of their sum. It is this process which utilises the long durations available in such records, and gives an advantage over spatial pictures of waves.

The only fundamental weakness in the method using two recorders is a lack of directional resolving power. A unique result is obtained for a unique direction, but for short-crested waves the value of $\cos \phi$ obtained is merely an average over a range of directions. Such an average is satisfactory when the range is not too broad, but it becomes misleading when there are two or more predominant directions. For example, if two discrete wave trains are present at $\phi = 30°$ and 150°, it is not very useful to know merely that the mean direction is 90°. By mathematical reasoning, it can be shown that to obtain a directional resolution which will sort out any distribution of directions we need also to measure the phase lags between recorders spaced by 2d, 3d, 4d, etc. For example, wave-height recorders at A, B, C and D in Fig. 2 contain all spacings from d to 6d, and if the required spectral analysis is carried out should give sufficient information for all engineering requirements.

An alternative approach is to introduce pre-assigned time lags into the signals and record only their sum, which is then heavily weighted in favour of a certain value of ϕ, according to the time lags. To be effective this requires a large number of wave recorders and some rather special electrical equipment, but it does enable a directional analysis to be carried out quickly, and with the minimum of computation.

Nevertheless, a line of recorders, no matter how numerous, cannot distinguish between $+\phi$ and $-\phi$. If it is an essential requirement to be able to resolve in **all** directions then the array must be extended in two dimensions. The simplest of such arrays is three recorders at the corners of an equilateral triangle. There are further variants of the above methods involving an array of recorders which anyone interested can follow up. A useful reference is "Optimum arrays for direction finding" by N. F. Barber,

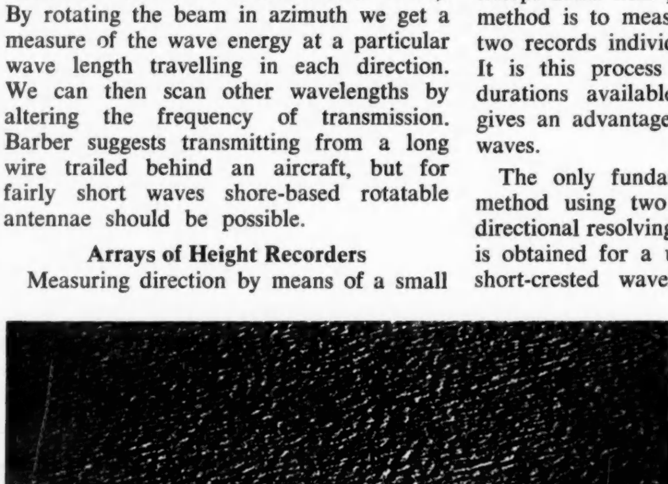


Fig. 1. Aerial photograph of a typical wind-generated area.

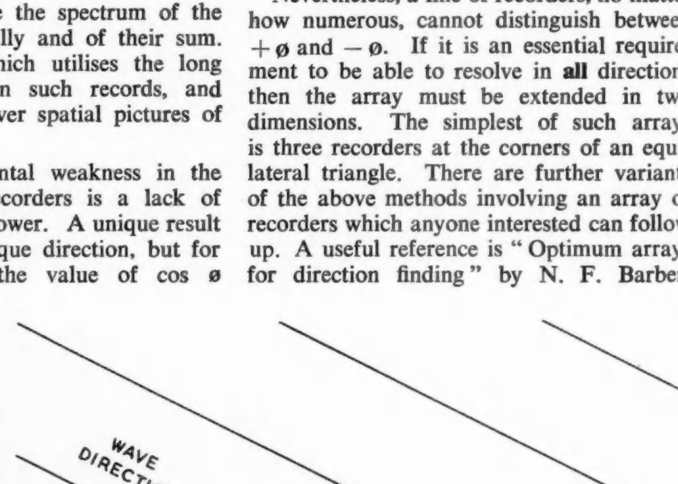


Fig. 2. Diagram of long-crested waves passing a linear array of four recorders.

"New Zealand Journal of Science," Vol. 1, No. 1, March 1958.

Multi-Component Recorders

We now turn to the last type of method of direction-finding mentioned earlier, which uses recordings of several characteristics of waves at one point only. The most practical instrument of this sort at present is the "pitch-roll buoy" developed at the N.I.O., which has recently been used successfully in connection with ship trials carried out by the British Shipbuilding Research Association and the National Physical Laboratory. Records are made of the vertical movement of the buoy and also of its tilt in two perpendicular directions (in effect the wave slopes). Referring to Fig. 2, if the buoy is situated at A, it is easily seen that the maximum slope in the direction AB is proportional to cos ø and the maximum slope perpendicularly to AB is proportional to sin ø. Thus the direction of a simple wave train as shown is determined uniquely without the ambiguity in sign of a line array. With a more complex pattern of wave directions of course the above estimate becomes a sort of mean direction, as before, but one can extract other quantities by cross-correlation between the three pairs of records, which together give quite a fair directional resolution. Some accounts of recent work done with such buoys are to be published shortly.

Another variant of the same principle as the pitch-roll buoy, which has been suggested but not yet tried out, is to record variations of water velocity in two horizontal directions beneath waves. This would require a current meter capable of recording rapid changes in direction, such as the N.I.O. "electrode flow meter" and also a conventional pressure recorder. These would be mounted rigidly on the sea bed. Either of these last two systems resolves wave directions about as well as a triangular array of three wave-height recorders. In order to obtain even better resolution a more complicated buoy which measures not only vertical movement and slopes, but also curvatures of the surface, is being designed. However, this is still in the experimental stage.

Wave Recording Instruments for Civil Engineering Use

by L. DRAPER, M.Sc., A.Inst.P. (National Institute of Oceanography).

Various terms used in the text are defined as follows:—

Wave: This term is generally used to mean those oscillations of the water surface which have periods of up to 25 seconds; no storm-generated waves with periods exceeding 25 seconds have ever been measured. Waves are often divided into SEA and SWELL; SEA refers to locally-generated waves, SWELL to waves which were generated elsewhere and have travelled out of the generating area.

Long Wave: This term is generally used to mean those oscillations of the water surface which have periods intermediate between 25 seconds and those of the tides (but not including tides).

This terminology is ambiguous; it is sometimes necessary to refer to waves with periods in the teens of seconds as longer waves. Until some generally-accepted term comes into use, care must be taken in the use of this term. Because of the association with range action it has been suggested that long waves with periods between storm waves and tides might be called "Range Waves."

Wave Height: The vertical distance between the crest and trough of a wave.

Wave Amplitude: This is used more in mathematical terminology and is the vertical distance between the still-water surface and the crest or trough of a wave. It is equal to half the wave height in a simple regular wave train.

Wave Period: The time which elapses between the passage of succeeding crests or troughs past a fixed point.

Seiche: Periodic change in water height usually encountered in lakes or harbours, due to the oscillation of the whole water mass.

Range Action: This is basically the same as a seiche, but seems to be used only in connection with harbours.

Attenuation Factor: The ratio of the pressure change on the sea bed, expressed in feet of water, to change in elevation at the surface, due to the passage of a wave.

Instruments for Measurement of Storm Waves

Instruments for measuring storm waves can be divided into three broad types:

(a) Those which measure from above the surface
(b) Those which measure at the surface
(c) Those which measure from under the surface.

(a) Those which measure from above the surface

Optical methods have been used. One method is to take a cine film of the change in water height at a calibrated vertical pole through the surface. Another method is to photograph repeatedly an area of the sea surface either with a single-lens camera or a stereo camera and subsequently to analyse the whole of every photograph. These optical methods require a high recording position, because when steep waves are present a high crest will obscure the following trough. A lot of work has been done on methods of analysis but all these optical methods require a large amount of effort in the extraction of data from the films. The methods all fail completely in very bad weather because the wave crests are blown off by the wind and the whole picture is obscured.

Wave recording from aircraft by radar altimeter is also expensive, and this method is still not perfected.

For most engineering requirements these methods are probably not of great value.

(b) Those which measure at the surface

Numerous attempts have been made to develop surface recording instruments. These instruments usually require some sensing element passing through the surface, and therefore some structure capable of holding it. The sensing element may be a resistance wire, held vertically through the water surface. The resistance of the wire is shorted out below the surface of the water by the water itself; the changing resistance is then a measure of the changing water height. Alternatively the changing resistance can be made to change the frequency of an oscillator; the frequency is then transmitted by cable or radio to the recording station and converted to an output proportional to changing water height. Similarly, capacitors at fixed intervals on a vertical pole may be shorted out by the waves and change the frequency of an oscillator. Another method is to have an insulated wire passing through the surface, and to use the changing capacitance between the insulated conductor and the sea to change the frequency of an oscillator.

If the measurements are needed at a place where there is no fixed structure, or in deep water where a vessel is stationed, the N.I.O. Shipborne Wave Recorder is probably the best available instrument. This instrument continuously combines measurements of pressure and vertical acceleration. The pressure measurement gives information on the height of the sea surface with respect to the ship; the vertical acceleration is integrated twice to give the vertical distance the ship moves relative to an arbitary fixed level. The sum of the two measurements eliminates ship motion and therefore gives a direct measurement of wave height (Tucker, 1956).

Several methods of recording waves from

a floating buoy have been devised and depend either on measuring the vertical acceleration of the sea surface, or on having a pressure-sensitive device suspended on a long wire below a buoy on the surface. In the latter system the pressure-measuring unit is raised and lowered by the buoy on the surface. Provided that the wire is long so that the unit is in still water below the action of the wave motion, it will give a record proportional to wave height. An un-anchored expendable accelerometer buoy costing less than 200 dollars has been developed in the U.S.A. It radios back wave information on the accelerations it experiences and can work for about eight hours. None of these buoys so far used seems to have much application to civil engineering problems. It should be possible to produce an anchored wave-recording buoy which could be left unattended for a reasonable period, but its development would be a major project.

All these instruments attempt to record accurately the changing shape of the water surface with respect to time. This is the basic information which we require, but it cannot be used directly by the engineer, who has to devise some analysing system to suit his needs. A surface instrument which attempts to do a direct partial analysis was devised by a Dutch engineer, P. J. Wemelsfelder. It has now been developed by a team at the Rijkswaterstaat into a reliable instrument which can be left unattended for long periods (Ferguson, Wemelsfelder and Santema, 1957). The instrument measures the total vertical movement of the water surface in a known time interval (integrated wave height), as well as taking a small number of graphic wave records. The authors claim that the maximum, significant and average wave heights can easily be correlated with the integrated wave height for any specific place.

(c) Those which measure from under the surface

Instruments in group (b) require to be placed in the water surface; this is often impracticable and a danger to shipping. However, the effect of waves on the sea is felt below the surface, so that if pressure changes are measured in mid-water, or on the sea bed in shallow water, a record can be obtained which is related in a known manner to the surface waves. This is probably the most popular method of wave recording and many instruments have been devised using this principle. For general wave recording the principal disadvantage of this method is due to the fact that the effect of waves is attenuated rather rapidly as water depth increases, so that if the instrument is sited at a depth of, say, 40 feet, waves of periods of less than about 5 seconds will not be recorded satisfactorily. The effect is shown in Fig. 1 (Draper, 1957). However, for many engineering purposes this filtering effect is actually an advantage, because it is the longer-period storm waves which contain most of the energy; if shorter waves are also recorded, the longer and more interesting waves are often obscured. One must, however, exercise caution in using such a natural filter, and take care not to throw away useful information.

It is always desirable to be able to check that the wave recorder is in working order, and an experienced operator can often decide this by looking at a chart record. For this reason most sea-bed instruments are connected to the shore recording station by a cable. This cable is often the most expensive item in an installation, because it has to be armoured, and often protected against marine boring creatures. In some long-distance installations it may only be necessary to use heavily armoured cable through the surf zone, and lightly armoured cable thereafter, but this means the use of another junction box, which is another possible source of trouble. Underwater cables are always liable to be damaged, so that an instrument which relies on the accurate measurement of a voltage or current produced by an underwater sensing unit is more likely to record inaccurately than one which depends upon recording a

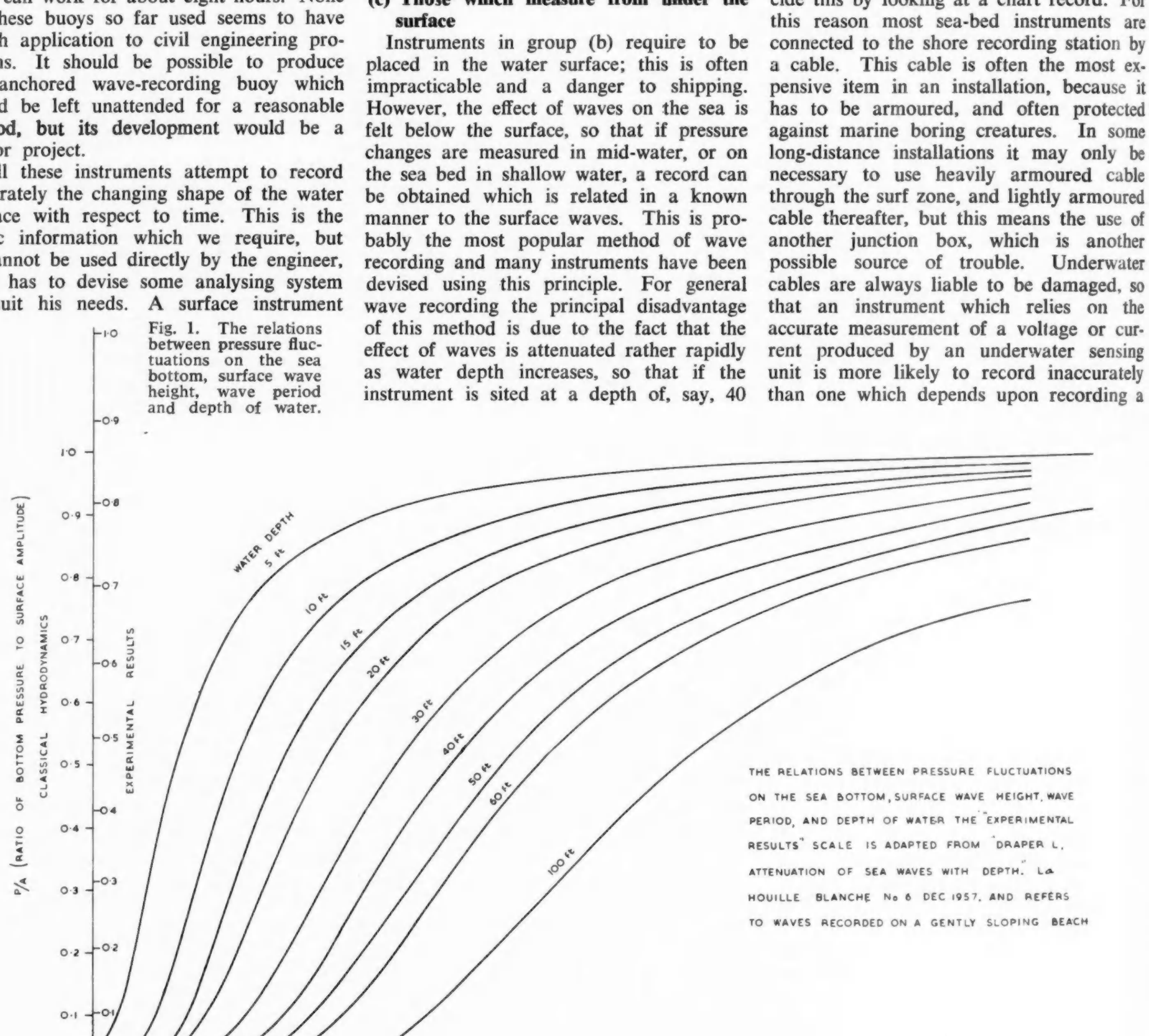


Fig. 1. The relations between pressure fluctuations on the sea bottom, surface wave height, wave period and depth of water.

change in frequency. A cable whose resistance is lowered by seepage of water may significantly change a voltage or current which is proportional to wave height, whereas, if that same cable is carrying a signal whose frequency is proportional to wave height, the record will be unimpaired provided the signal is still above noise level. In other words, the accuracy of recording is much less dependent on the state of the cable in F.M. (frequency modulated) systems than in voltage or current-dependent systems.

There are some pressure-measuring instruments which are self-contained and are designed to operate on or above the sea bed away from a coast. They are left for a period of, for example, a month, with a recovery line attached to a buoy. They have several disadvantages; one cannot be certain that the instrument is operating satisfactorily and therefore it may be a long time before a fault is discovered; it is not possible to switch them on for additional periods as and when required, although one instrument does contain an ingenious device which will take additional records if the wave height exceeds a certain value. There is always the danger that the instrument will be swept away in a storm, or that unauthorized people might be tempted to haul it up to satisfy their curiosity. However, if the distance to a shore having a satisfactory power supply is so large as to make the cable cost prohibitive, it may be necessary to resort to these self-contained instruments

A method which initially appears to overcome many of the difficulties is the use of an inverted narrow-beam echo-sounder on the sea bed. This measures the actual distance between the unit and the surface. giving a direct record of wave height. Considerable care has to be taken to align the beam in the vertical, unless the transducer is mounted in gimbals. There are two disadvantages with this type of instrument; firstly, there is a possibility of obtaining a spurious early echo from the shoulder of a wave if the waves are steep; secondly, in very bad weather when records are vital, there is considerable aeration of the surface and the sound may be lost by scattering, producing no echo at all.

Analysis of Records

Snodgrass and Putz (1958) of California have devised instruments which attempt to analyse automatically the output of an electrical wave recorder during the actual recording. These instruments have two outputs; one is a measure of mean wave height; the other records the total number of times that the surface passes through its mean position so that a measure of mean period is obtained. The mean wave height can be shown to be related to other statistically significant factors, such as the height of the highest one-third waves (Cartwright and Longuet-Higgins, 1956).

Long-Wave, or Range Wave, Recorders

Instruments for the measurement of range waves are almost all pressure recorders which have a band-pass response, removing both storm waves and tides.

General

Whatever type of instrument is used, waves should be recorded as near as possible to the place at which the information is required, because changes in depth and tidal currents can cause significant changes in wave characteristics. Normally it is necessary to record waves over a period of at least a year, but this can, if necessary, be reduced to one winter. Usually it is adequate to record the waves for a quarter of an hour every three hours. The probability of the occurrence of a wave of any particular height can be calculated from a set of intermittent records, so that continuous recording is unnecessary. In fact it would produce a mountain of records which would defeat the most enthusiastic analyst.

Conclusion

It is not possible to specify one particular instrument as a universal wave recorder; each type of instrument has its own particular advantages and disadvantages which may make it ideal for one job and virtually useless for another.

Firstly, one must consider what information is required and what inaccuracies can be tolerated. For instance, as described in group (c), a pressure recorder on the sea bed in relatively deep water will be of no use if short wave-length waves are to be measured, whereas if only longer waves are of interest the loss of short waves from the record will be an advantage.

Secondly, if no suitable power supplies are available, the choice of instruments may be restricted to those which either need no power or will operate from batteries.

Thirdly, the cost of the instrument and of its installation and operation will obviously have to be taken into consideration. It may be that an initially expensive instrument which analyses the records automatically will be cheaper, in the long run, than a relatively cheaply bought and installed instrument which might involve a lot of work in the analysis of its records.

Fourthly, it is always an advantage to have a graphic output from a wave recorder. An experienced operator can often tell from a graph whether or not an instrument is functioning properly. For this reason it is not advisable to use the self-contained pressure-recording instruments unless all other methods are unsuitable; nor is it often advisable to have an instrument which gives only a partially analysed output and no pictorial wave record.

Before an instrument is chosen for any particular project the problem must be considered from all these aspects. The final decision will inevitably be a compromise dependent on the relative importance of each factor in the project in question.

Note: The author would be most grateful to hear of wave-recording instruments which are not mentioned in this paper, and would be especially interested to hear comments, favourable and otherwise, on the use of particular wave recorders.

Copies of an Appendix to this paper, detailing recent types of instruments designed for the measurement of sea waves, can be obtained from the National Institute of Oceanography, Wormley, Godalming, Surrey.

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Stevedoring Productivity at the Port of Haifa

Abstracts from Data Issued in Third Report

This is the third Report on this subject to be published in English by the Haifa Port Directorate, the first appearing in March, 1953 and the second in April, 1957. These studies, it is stated, serve several purposes: they provide output data that help in establishing stevedoring charges, they enable the rate of progress in the field of cargo handling to be measured, and they provide an important indication of overall port efficiency.

"Port efficiency", the Report continues, "depends not only on stevedoring productivity but also on the total throughput of the port, which is largely influenced by other factors, such as the number of shifts worked per day, the number of gangs employed per shift and the availability of ship berths".

The Report analyses stevedoring productivity in three ways—(1) for individual classes of cargo; (2) collectively for all classes of cargo except those handled by the special grain and potash plants; and (3) for all cargo, including grain and potash. Productivity rates for (1) are expressed in tons per gang hour, for (2) in terms of Labour Productivity Index and for (3) in terms of Overall Productivity Index. The Labour index is defined as the ratio of gang-hours needed for "standard" outputs, to the gang-hours actually spent. The Overall index is the same, except that it includes cargoes handled by grain elevator and potash conveyor.

The following extracts of the body of the Report will be of interest.

Movement of Productivity Indexes in 1960.

The Overall Productivity Index advanced in 1960 on the average by six points against 1959, viz., from a yearly average of 146 points in 1959 to 152 points in 1960 (the Index base is December 1952=100 points). The Labour Productivity Index, advanced by five points, from 118 points in 1959 to 123 points in 1960. Both indexes thus rose by 4% over last year's level.

The six point rise in the Overall Productivity Index was caused mainly by higher output rates of grains handled by the silo elevators (+ 2 points), by minerals in bulk, other than potash (+ 1.6 points), by citrus fruit (+0.8 points), cement (+0.6 points) and miscellaneous other cargoes (2.4 points). These advances were in part set off by lower output rates of heavy wooden logs (−0.8 points) and miscellaneous other cargoes (−0.6 points).

Output rates by classes of cargo.

Percentagewise, oil cakes in bulk show the highest increase (+30%) in output rates over 1959, while tin plate clippings show the largest decrease (−38%) among the main classes of cargo.

If the cargo quantities handled are also taken into account, the important productivity changes during the year were those of soya beans in bulk (+15%), minerals in bulk discharged (+21%) and loaded (+10%) grain in bulk (+7%), heavy logs (−9%) and boxboard (−9%).

The decrease in the output rate of the heavy logs has now been going on for three years, and the present rate of 14.4 tons per gang-hour is 33% below that for 1957. The reason for the decrease lies in the old types of vessels, with narrow hatches and rickety tackle, that used to carry this trade. Since December 1960, modern special vessels were commissioned for the transport of logs, and output has been improving.

Among the sub-classes of general cargo loaded, significant increases in output rates were registered by plywood (+20%) and eggs (+10%).

Productivity by type of gear.

Shore cranes again proved superior to ship's gear, especially for bulk cargoes. On the average, the productivity of the port's level-luffing 3-5 ton cranes was greater by 17.8% than that of vessels' gear. The productivity of mobile shore cranes and floating cranes was even greater, but the use of these types of gear is limited to special cases.

It may be mentioned that the use of level luffing portal cranes has been markedly extended at Haifa Port during the last few years due to the gradual acquisition, from January 1958 onwards, of 14 of those cranes. The following table shows the development of the percentage share of the various types of gear, excluding elevators and redlers:—

	1957	1958	1959	1960
Ship's gear	84	78	74	69
Level luffing portal cranes	9	20	24	29
Mobile shore cranes and floating cranes	7	2	2	2
Total, excluding elevators and redlers	100	100	100	100

The poor performance of portal shore cranes on general cargo n.e.s. (3.9 tons per gang-hour) is also due to a technicality. The item usually includes only minor quantities of many different cargoes not elsewhere specified. This year a sizeable consignment of scrap iron was imported for the first time and included in the item. The rate of discharge of the scrap iron was very low and since most of the scrap was handled by portal cranes, this reduced their average output for the item to below that of the other cranes.

Productivity by homogeneity of cargo handled.

Long runs of a cargo, permitting stevedoring gangs to work continuously on one class of commodity for one or more shifts resulted almost inevitably in higher output rates than short runs of several mixed cargoes. The weighted average this year shows an overall advantage of 9% in favour of the homogeneous cargoes, as against 6% in 1959.

Productivity by number of gangs employed per hatch.

Last year the performance of double gangs on the average fell short by 12% of that of single gangs. This seemed to confirm the opinion held in many ports that double gangs interfere with each other's operations, thus reducing output rates. This year, however, the difference in productivity has narrowed down to a mere 1.5% on the average. By individual classes of cargo, the picture becomes even less clear-cut, since double gangs actually performed better than single gangs in 11 cargo classes, performed worse in 10, and were even in two classes.

It would seem that double gangs are now being employed more selectively than in the past and that their use is restricted to larger vessels with hatches wide enough for two gangs to work without interfering with each other.

Productivity by shifts.

The productivity of the three shifts per gross gang-hour presents much the same pattern as in the past: the night shifts (24.00 hrs. to 06.00) lag behind the day shifts (06.30 to 15.30 including one lunch hour) and the second shifts (16.30 to 23.00) more so than the third. The relative productivity of the three shifts may be seen from the following table where the productivity of the various shifts are expressed in percentages of the first shift productivity:

Shift	1953	1954	1955	1956	1957	1958	1959	1960
First	100	100	100	100	100	100	100	100
Second	92	87	85	85	86	88	91	90
Third	93	90	93	88	83	93	92	93

The picture becomes, however, strikingly different when we deduct from the gross gang-hours worked in the three shifts all hours lost due to early leaving and recalculate the shift produc-

tivity per gross gang-hours, minus early leaving. The following table shows the relative productivity figures thus recalculated for the three shifts, and expressed once more as percentages of the productivity during the first shift:

Shift	1957	1958	1959	1960
First	100	100	100	100
Second	88	91	98	97
Third	86	100	101	109

Productivity during the night shifts has thus very much improved during the last years and it was in 1960 actually 9% higher in the third shift than in the first. The gain was, however, completely offset by earlier leaving, on which more will be said later.

The following table amplifies the 1960 figures given above.

Productivity by shifts in 1960

All classes of cargo*

Shift	Quantity of cargo tons	Gang - hours		Ratio of standard hours to worked hours in %	Productivity in night shifts as against productivity in first shift - in per cent	
		Needed according to standard	Actually worked		1960	1959
1st 6.30 - 15.30	890,405	56,723	51,663	109.79	100.0	100.0
2nd 16.30 - 23.30	400,669	28,694	29,105	98.59	89.8	91.[illegible]
3d 0.00 - 6.00	52,128	4,733	4,630	102.22	93.1	92.2
Total	1,343,202	90,150	85,398	105.56		

* Grain handled by elevator and potash handled by conveyor are excluded from this table.

Non-productive working time.

The anaylses of non-productive working time refers only to the stevedorage of cargo tallied by the Port Directorate, and, unless otherwise specified, to cargoes handled over the grain silo and the potash plant. The figures do not include work on untallied cargoes, such as bulk cargoes handled by grabs, sawn wood, and citrus fruit, where time losses were not recorded.

With two exceptions, all time losses have been included in the gross working time used for computing output rates for the various classes of cargo. The exceptions are, first, the late arrival of the ship, when workers stand by idle from the beginning of the shift until the ship has been berthed; second, the running out of the cargo before the shift is ended.

Non-productive working time of the grain silo and especially the potash plant has this year been reduced against last year's figures, but total time losses increased for all other cargo handling. This was due to the growing incidence of early leaving, which has been gaining momentum for several years and has been particularly conspicuous during the night shifts. This will be seen from the following figures which refer to all operations, other than those of the silo and the potash plant.

Early leaving, expressed as a percentage of gross working time.

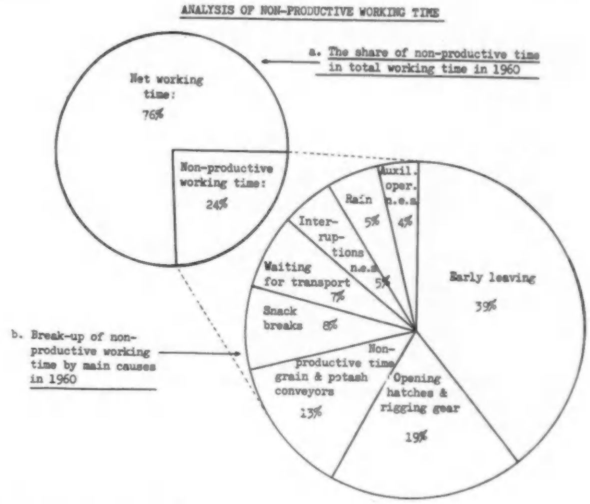
Shift	1957	1958	1959	1960
First	3.4	4.4	5.9	9.0
Second	5.5	8.5	12.4	15.5
Third	5.9	11.4	13.8	22.0

The steep increase of early leaving is closely connected with the growing use of setting output targets on the completion of which stevedores are allowed to leave. In the past, early leaving had been caused in the main by poor discipline on the part of the dockers, and, although condoned, was not sanctioned by the Port Contractor's management. But for the last two or three years, an entirely different kind of early leaving has been actively encouraged by the foremen, and this sort of knocking off early is more in the nature of a new form of incentive pay.

There is at Haifa, unlike at many other ports, no large reservoir of skilled port labour, besides the men permanently or semi-permanently employed by the port contractors, which can be drawn upon whenever required. In consequence, stevedores employed during the first shift often stay over to work during the second shift; the third shift, which is only worked occasionally, is practically always done on overtime. In these circumstances, cash premiums offer little attraction to the men and this is where the task work comes in: work management and workers set a target for the shift; when the target is reached, the men are free to knock off.

As has been said before, early leaving is compensated for by higher productivity during the night shifts, and it would seem that productivity is highest when the men are engaged on task work.

ANALYSIS OF NON-PRODUCTIVE WORKING TIME



Turnround of vessels.

The turnround time of all dry cargo vessels from arrival to end of discharge improved slightly in 1960 and totalled 4.9 days as against 5.1 days in 1959.

This might seem surprising since cargo traffic other than oils increased by 10% over last year, yet no new quayage was added during the period.

The increase in the cargo traffic related, however, almost exclusively to bulk commodities, mainly grain and seeds, and not to piece goods, as is evidenced by the following analysis of the cargo traffic other than oils in Haifa Port (including the Kishon Auxiliary Harbour) in 1960 and 1959:—

	1960 '000 tons	1959 '000 tons	Increase %
All dry cargoes	2,677	2,427	10
Grain and seeds in bulk	888	710	25
Other bulk cargoes	374	318	18
Piece goods	1,415	1,399	1

The brunt of the increase had therefore to be borne by the grain silo, and the turnround time of grain carriers was indeed slowed up from 11.7 days on the average in 1959 to 12.7 days in 1960. Cargo vessels other than grain carriers shortened their turnround during the period from 4.5 days to 4.2 days, and this resulted in the slight overall improvement for **all** dry cargo vessels from 5.1 days in 1959 to 4.9 days in 1960 mentioned above.

The slow turnround of grain carriers was caused by a lack of balance between the incoming shipments and the unloading possibilities or rather the rate of clearance from the silo. Grain traffic intensity was such that long waiting times of grain carriers were bound to occur, since occasional bunching of grain carriers is almost inevitable with random arrivals.

Two factors contributed to the acceleration of discharge per ship-day. They were, first, the increase by 4% in the number

of gangs employed per ship-day, and secondly the higher mean daily output of the gangs, which rose by 15%. The latter factor resulted on the one hand from the higher productivity, as reflected in the Productivity Index, and on the other hand from a marked shift toward bulk cargoes, the throughout rates of which are naturally higher. Figures in support of the gang output rates and the number of gangs employed per ship-day worked are given hereunder:—

	1960	1959	1958
(1) Total tonnage discharged, including cargo from passenger vessels—'000 tons	1,674	1,472	1,320
(2) Total ship-days worked	2,308	2,472	1,986
(3) Mean tonnage discharged per ship-day worked	725	605	665
(4) Number of stevedore gangs employed	11,743	12,070	10,756
(5) Mean number of gangs per ship-day worked	5.09	4.88	5.42
(6) Mean tonnage discharged per gang	143	124	123

Cargo handling activity

An important factor which considerably eased the task of coping with the increased cargo traffic of 1960 was the relatively equal distribution of the flow of cargoes throughout the year. Except for the month of February, imports were remarkably steady and most of the fluctuations in the other months were in the grain trade which, being largely automated, has only a limited influence on port operations. Exports, too, were well balanced during the year but for citrus fruit which retained, of course, its seasonal character.

More decisive yet than the even cargo flow by months was the relative constancy of the day by day port activity. Fluctuations in the daily cargo handling activity are best measured in terms of the daily number of stevedore gangs employed. The average number for the port, including the Kishon Auxiliary Harbour, rose from 53 in 1958 to 64.6 in 1969.

The Report is a comprehensive document of nearly 50 pages, 36 of which are devoted to tables, charts and diagrams. Gang productivity and ship turnround time are rightly examined as separate questions, because, although the aim is to enable the vessel to spend as short a time in port as possible, the opportunity for men to work well and earn well must not be taken away, as can easily be done if too many gangs are allocated to the same ship. A careful balance has thus to be preserved and one of the ways of ensuring that the right emphasis is being given to all aspects of stevedoring work is periodically to make studies such as that under review. If more goods are carried in the future on pallets or in containers, no doubt these types of traffics will be analysed separately by the Research Section of the Port of Haifa, and such information would be of considerable interest to port operating organisations generally.

The Report deals with increased productivity resulting from the use of shore cranes, the number of gangs employed, the types of cargo handled and shift work, but makes no reference to one important factor which can vitally affect outputs, viz. mechanisation. This subject always raises the associated question of gang-manning (and also wasted man-hours), about which there is much controversy all over the world.

Publications Received

Hong Kong Commerce, Industry and Finance Directory, 1961. Illustrated, 96 pp. Copies may be obtained, free of charge but please send an addressed label with 1s. 1d. stamps), from the Hong Kong Government Office, Grand Buildings, Trafalgar Square, London, W.C.2.

This Directory is designed as an overseas businessman's guide to the commerce, industry and finance of Hong Kong in 1961. It illustrates the pattern of the Colony's trade and industry and indicates the measures being undertaken in collaboration by the Government, merchants and manufacturers to promote Hong Kong's trade, particularly in the field of exports.

Rotterdam Year Book 1961/2. Published by Hafenkurier Weekly, Rotterdam. Price 11s., well illustrated.

This handbook describing Greater Rotterdam has been published as a guide for all who have anything to do with the city, for not only is Rotterdam one of Europe's largest ports, but it also serves an area where heavy industry and its related trades have greatly expanded. The need for a comprehensive handbook becomes evident when it is realised that Rotterdam forms an organic part of the industrial areas grouped along the Rhine, in both Germany and France, and that its economic links extend into Switzerland and Austria. In fact Rotterdam is the focal point of the Rhine delta.

In compiling the handbook, the publishers had the co-operation of the authorities of Rotterdam and adjacent towns, the Rotterdam Chamber of Commerce and the Rotterdam Port Foundation. In its nine chapters the handbook deals with the main aspects of the regional economy, each containing one or more articles on the structure and position of a trade or industry of importance to Rotterdam. There are articles among others on the port and shipping, shipbuilding and repairing, banking and insurance, wholesale trade, and road transport. The articles are in German or English appropriate to the particular subjects, a summary in the other language being given in all cases. The fullest possible lists are added, giving addresses and further particulars of firms in each trade; these include shipping companies, shipbrokers and forwarding agents, stevedores, towage companies, salvage companies, superintending, storage and warehouse facilities.

Scandinavian Research Guide. A Directory of Research Institutes within Technology and Science Exclusive of Life Sciences. In Two Paperback Volumes, 1,192 pages. Price £3 10s. ($10.00) the set.

This is the only Dictionary which covers the whole field of scientific and technical research in the five Scandinavian countries. The Scandinavian Council for Applied Research (SCAR) in publishing this work is aiming to further co-operation between institutions and persons engaged in scientific and technical research. It is also intended as a source of information for industrial enterprises and trade organisations, interested in making research contacts. Governmental, semi-governmental and co-operative institutes as well as private laboratories which undertake contract work for others have been included. To facilitate consultation of specialists and the placing of contracts, information concerning policy in these respects has been included in the account of all those research institutes that undertake sponsored work.

Industrial Plant Stock List. Published by the Industrial Plant Department, Thos. W. Ward, Ltd., Albion Works, Sheffield. 16 pp. booklet, fully illustrated.

The first issue of a new stock list, which will be produced at regular intervals, has been published by the Industrial Plant Department of Thos. W. Ward Ltd. It lists current holdings of boilers, tanks, pipes and tubes, air receivers, valves, scaffolding, ladders, etc. and it also gives details of the Department's activities in specialised fabrication.

It is intended to send the issues, as published, to all on a specialised list, but the department will be pleased to add the name of any interested firm or potential customer.

Manufacturers' Announcements

Lighthouse for Ghana

The apparatus for a new lighthouse has recently been completed at the Stone-Chance works at Crawley, to the order of the Ghana Railway and Harbour Authority, and will shortly be installed on the summit of a water tower at Takoradi.

The optical equipment and rotating mechanism on test at Crawley works.

This new light has a lens of prismatic optical glass rotating around an electric filament lamp by an electric motor. The whole apparatus will be housed inside a traditional type lighthouse lantern 7-ft. in diameter but there are some ingenious safeguards. For example, if a lamp fails the automatic lampchanger brings the standby lamp into focus, if the motor rotating the lens fails a further motor will start automatically and if the mains supply fails a standby power plant will restore the supply to the lighthouse within a few seconds. Two flashes of over half a million candle power will be given in quick succession.

Valued at approximately £10,000, this is the sixth electric lighthouse installation supplied and installed by this firm on the coast of Ghana in twelve years and the navigational aids along the coast are now amongst the most modern in the world.

New Flooring Compound

A flooring compound, known as Maximent, is being introduced to the market by the Surface Coatings Division of Burt, Boulton & Haywood Limited. Its purpose is to provide industrial and commercial premises with a flooring material that will withstand the hazards that have hitherto made all known surfaces impermanent and costly. For instance, many concerns are continually faced with expensive repair or resurfacing of floors or working areas damaged by the passage of vehicles and the movement of people. In specialised industries, the use of chemicals, fats, greases, sugar syrup, etc., is destructive to the usual floorings and in factories and laboratories where delicate instruments and apparatus are in use or are actually being produced, the 'dusting-up' of concrete floors can completely ruin the work.

Maximent is said to offer an immediate and lasting answer to these problems. The material is a liquid dressing, applied over a prepared base. This base consists of a screed of preferably 3: 1 sand cement, properly laid and dried, then followed by a primer which takes only a few hours to set before the finish coat is applied. The finish coat in turn takes only a matter of hours to set and normally the floor can be in regular and permanent use again the day after it has been laid.

Maximent is easily applied by simply brushing or moving it over a measured area. It finds its own level and sets without brush or tool marks. At a usual thickness of only 1/16-in., it is said to provide a surface many times stronger and more durable than granolithic concrete. Whereas concrete soaks up oil and grease, all that is required with Maximent is to wipe the surface clean.

An aggregate can be incorporated to give a grip finish that is invaluable for slopes, and can be supplied in various attractive finishes.

Portable Site Office

A new portable office providing adequate and well equipped accommodation in the shortest possible time has been introduced by Portasilo Ltd. of York.

Constructed as a single unit, with sides and roof in one piece, the Portakabin in unusual in that it has telescopic legs on which it is raised and lowered by jack, and it can be taken off a lorry by one man in fifteen minutes. It arrives on the site fully equipped and ready for immediate use and can be removed intact for use elsewhere. If required and to save space, one office can be placed on top of another to make a three-storey block, or it may be placed into a building project to be lifted by crane from floor to floor as the new building is erected.

Robust construction equivalent to that of many permanent offices is based on the use of resin bonded plywood. The use of this plywood was developed by the Company in the production of their portable cement silos which are now widely used. The offices are stored and delivered wrapped in polythene.

The Portakabin has adjustable louvred windows and may be fitted with electricity and telephone with adaptors for immediate connection. The doors are split on a stable design with the top half opening in line with large windows giving light and spacious appearance. A range of specially designed fittings enable it to be used for a wide variety of duties.

The Grab Dredger "Garsem"

Priestman Brothers Ltd. have recently completed a grab dredger which is the fourth they have supplied to the M.B. Dredging Co. Ltd. The dredger is fitted with a No. 750 size diesel-driven grab dredging crane which operates a $3\frac{1}{2}$ cu. yd. capacity mud grab at a maximum radius of 32-ft. to a depth of 70-ft. below water level. The vessel is of the non-propelled type and has dimensions of 106-ft. in length, 30-ft. beam with a depth of 7-ft. and a loaded draught of under 4-ft.

The two electric winches, one of the 4-drum and one of the 2-drum type, are mounted on deck at the forward end, and handle the six mooring lines used during the dredging operations. The maximum pull from the largest drums is 7 tons and from the smaller 5 tons.

Power for the winches, for lighting, heating, cooking, pumping and battery charging is provided by an 80 kw. alternator providing

The new grab dredger "Garsem".

440 volts, 3 phase, 50 cycles alternating current and nearly one mile of electric cable was used in all the circuits on the vessel.

Accommodation is provided below decks for four men, and consists of a sleeping cabin, galley with electric stove and water boiler, and a separate wash-place.

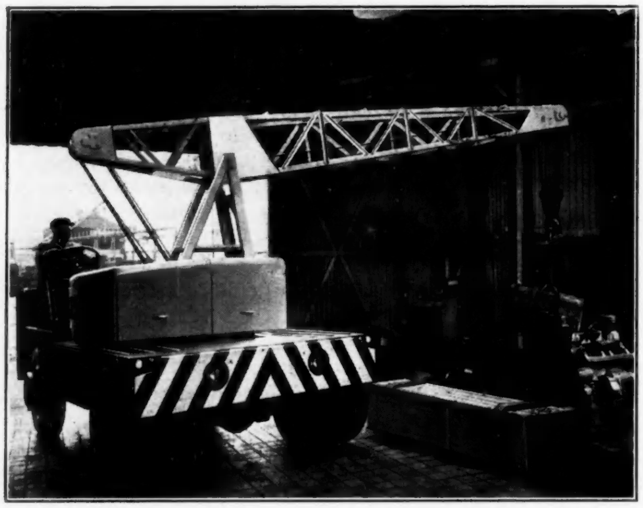
The No. 750 size Dredging Crane has pneumatic controls, and the driver has good all-round vision of the working end of the crane. A 300-tons capacity barge can be filled with mud in 45 minutes when working at a depth of 37-ft.

New Mobile Crane

Designed by Steels Engineering Products Ltd., of Sunderland, to meet the requirements of the European Common Market, the Coles Leda is a four ton capacity mobile crane with full circle slewing. Its outstanding characteristics are easy manoeuvrability and narrow turning circle (less than 12-ft.) and because of its compact design it has proved extremely valuable for work in narrow aisles and where headroom is low—overall height is only 8-ft. on the street version and 9-ft. 10$\frac{1}{4}$-in. on the cantilever.

The crane is also capable of sustained road travel (the fuel tank has a capacity of 20-gal.) and gradient negotiation. It has a maximum speed of 17.6 m.p.h. and, at peak torque, can negotiate a gradient as steep as 1 in 3$\frac{1}{2}$. Range before refuelling is about 250 miles.

The power unit, mounted in the crane carrier chassis, consists of a Ford diesel engine developing 52 b.p.h. at 1,800 r.p.m., with a dry plate clutch and four-speed gearbox which provides the power for the travel motion. A variable speed generator driven by power take-off from the diesel engine energises the electric motors of the three crane motions—hoisting, derricking and slewing—by direct current.



Coles 4-ton capacity Leda, equipped with cantilever jib, operating in conditions of low headroom.

Each motion of the crane is controlled by an interlocked pair of heavy duty reversing contactors operated by pilot switches conveniently located in a console in the driver's cab. These switches are of particular interest. One combined pilot switch operates both the hoist and slewing motions and the other single switch, the derricking action. This combined two-motion pilot switch will, it is claimed, enable the operator considerably to speed up handling cycles. With it he can simultaneously or independently operate both the hoist and slew motions with one hand, leaving the other hand free to steer or operate the derrick motion.

The hoisting and derricking are controlled by several safety devices and an automatic self-load indicator is also available. This continuously weighs every load and warns the operator both visually and audibly of any tendency to overload and automatically prevents the lifting of an unsafe load irrespective of the position of the jib. Maximum load of the crane—in both its street jib and cantilever jib form—is four tons. When equipped with the street jib, the Leda's standard jib length is 20-ft. Of lattice construction, this basic jib can be supplemented by additional sections, each of which measures 10-ft., until a maximum jib length of 50-ft. is reached. With a basic jib, the crane has a maximum radius of 19-ft. (blocked) and 17-ft. 6-in. (mobile). When fitted with its maximum jib of 50-ft., the blocked radius is increased to 30-ft.

Both the steering axle wheels and the driving wheels are interchangeable—a feature uncommon in current crane practice.

Versatile Fire Fighting Equipment

A revolutionary new fire-fighting and rescue device has recently been introduced by Simon Engineering Dudley Ltd., Dudley, Worcester. Developed from the Simon hydraulic Platform, the new unit known as the "Simon Snorkel" is a 65-ft. elbowed arm mounted on a turntable on a carrying vehicle, and capable of a complete range of vertical, horizontal and rotary movements. A cage at the end of the arm carries the monitor which is supplied through 3$\frac{1}{2}$-in. water pipes attached to the arm. The cage also has ample room for at least six men. The lifting capacity is 1000-lb., there is a horizontal outreach of 34-ft. and the equipment will attain maximum working height in 50 seconds. All movements are governed by simple hand controls in the cage and duplicate controls are provided on the turntable for operation from ground level if required.

Similar fire-fighting units are already in operation in the U.S.A. and an officer of Chicago Fire Department has described the machines as one of the greatest advances in fire-fighting and rescue techniques in more than 20 years.

Recent Contracts for Cargo Handling Equipment

Against world competition Yale & Towne British Materials Handling Division has secured an order worth £26,000 from the Treasury, Malta, for 16 trucks for use in the port of Valletta. The 11 Warehouser platform models and four K.51 Fork Lift Trucks with attachments were shipped from Yale's Wednesfield factory early this month.

The Division has also been successful in obtaining an order for 40 Worksaver Pallet Trucks worth approximately £25,000. These will be delivered over the next 18 months to the Fred Olsen Line, Norway. The trucks have been specially designed for use on board ships.